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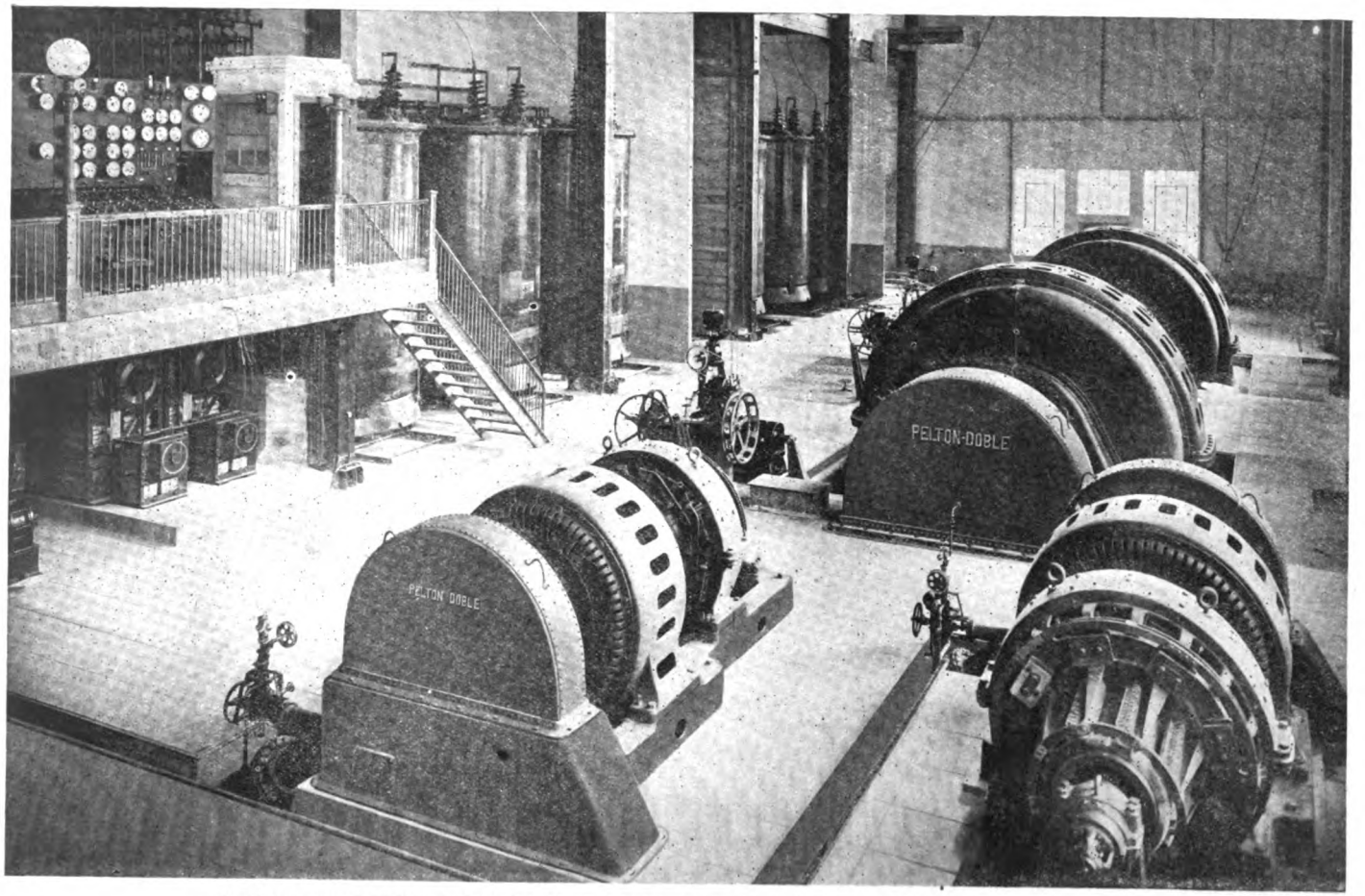

INTERIOR DRUM POWER-HOUSE, LAKE SPAULDING PROJECT FOR THE PACIFIC GAS & ELECTRIC CO.
VIEW TAKEN A SHORT TIME BEFORE COMPLETION. (See Page 173.)

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EDITORIAL

CONGESTION of traffic at the San Francisco ferry terminal is a menace to pedestrians increasing day by day. Approximately 100,000 commuters cross the embarcadero during the evening rush hour, and it is due to the efficiency of the traffic squad that so few accidents have occurred. Mr. M. M. O'Shaughnessy, city engineer for San Francisco, has suggested that an elevated loop be constructed that will provide for both street cars and pedestrians, thus leaving the embarcadero free for vehicles of all kinds. There is no doubt that some such remedial measure should be undertaken at once.

CALIFORNIA is generally looked upon as being violently radical in its political tendencies, but now New York is coming to the front with some ideas on the subject of the disposal of state water rights that seem almost ultra-western. Three bills have been proposed by the state conservation commission. The first empowers the state to regulate the flow of streams, to erect and maintain storage reservoirs, to acquire by condemnation or purchase water rights and power plants, and to construct or otherwise acquire property of any nature which may be necessary for the transmission and distribution of hydro-electric energy. Authority is given in the bill for the commission to contract with municipal corporations or public service companies for the sale to them of the state-generated power. The bill drafted for the development of hydro-electric power in the Albany district, which was vetoed, has been redrafted and will be introduced. This bill in general authorizes the commission to develop hydro-electric power from the surplus water in the canals and canalized streams of the state for sale to municipalities and other consumers. The third bill is the same as the Albany bill except that it authorizes the commission to construct a hydro-electric plant at any point to be selected by the commission along the line of the barge canal. For this purpose $700,000 is appropriated of which $300,000 is made available in 1914. If these bills are passed, the state will be definitely committed to the generation and distribution of hydro-electric power not only to every municipality in the state, but to corporations and individuals as well. It begins to look as if before long there would be nothing left of the opponents of state and municipal ownership but the noise.

VALUE of engineering services has heretofore received little appreciation from states and municipalities. Practically all of the various state and city engineers were badly underpaid until some months ago it fell to the lot of San Francisco to introduce an innovation by fixing the pay of the city engineer at $15,000 per year and thus secure the services of a man of recognized professional standing and ability. New York has now followed suit, the salary of Mr. Alfred Craven, chief engineer for the Public Service Commission having been fixed at $20,000 per annum. It would appear that the engineer is at last being recognized

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as a factor in public affairs as Mr. Craven's salary is double that of the governor of the state and $5000 greater than that of the mayor of New York City.

ELECTRIC propulsion of vessels has arrived, as the performance of the U. S. collier *Jupiter* during her recent sea trials has dispelled any doubt that may have existed as to the practicability of the new method of drive. Contracts were closed in July 1911 by the U. S. government for three colliers, the *Neptune*, *Cyclops*, and *Jupiter*. The *Neptune* is equipped with steam turbines which drive the screws through a mechanical gear held in a floating frame. The *Cyclops* has two triple expansion reciprocating engines while the *Jupiter* is equipped with a 6-stage Curtis turbine driving a bi-polar alternating current generator. At 14 knots, the contract speed, the speed of the unit is about 2000 revolutions per minute and the voltage about 2200. The generator is a 5450 kilo-volt ampere 2300 volt machine which delivers current to two 2750 horse-power 110 revolutions per minute 2300 volt 36 pole motors, each of which is direct connected to a propeller shaft. The ratio of synchronous speed reduction is 18 to 1, the propellers turning at 110 revolutions per minute for a ship speed of 14 knots. On the official trials which took place during the week ended February 20, the *Jupiter* exceeded all expectations. During the 48-hour test an average speed was sustained of 15 knots per hour with a water rate of 11.72 pounds and during the 24-hour test a speed was maintained of 10 knots per hour at a water rate of only 10.4 pounds per shaft horse-power. The water rate guarantees were 15 and 13 pounds maximum respectively. During the shop tests of the apparatus before shipping, the water rates were 14.2 and 12 pounds respectively so the turbines appear to have given an appreciably better performance on the official than on the preliminary trials. A fuller discussion of the *Jupiter* trials will be given later, in the meantime it would appear that engineering practice with regard to marine propulsion is facing a revision.

The Impulse Water Wheel

In connection with Mr. A. E. Chodzko's article in this issue dealing with hydro-electric developments on Bear creek, it is interesting to note the remarkable evolution that has occurred during the last 20 years in what has been known as the Pelton or impulse water wheel. Originally devised for use as a somewhat minor accessory in the operation of mine reduction works, it has come to be the only recognized form of hydraulic prime mover in the utilization of high water heads, and through the perfection of regulating devices and the use of multiple runner units has encroached to a considerable degree on the comparatively low-head field where the turbine once held undisputed sway. Just who was actually responsible for the discovery that by parting a jet of water in the middle and discharging the two halves at an angle away from the periphery of the wheel, nearly 85 per cent of the energy of the falling water could be converted into useful work is open to question. Although the fundamental principle of the impulse wheel is unchanged in the modern product, many changes in mechanical construction have been devised to meet the demands of continuous operation in central station power plants. The rotors for the Drum power house are made up of two separate cast steel

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discs, with hubs abutting one another in order to maintain correct distance between the wheel rims. Each bucket has three lugs, one in the centre and two outside. The outside lugs are toward the rear of the bucket when viewed in the direction of the issuing water jet, and the central lug is in front extending somewhat beyond the face of the bucket. The front lug sets between the rims of the two wheel discs while the two rear lugs straddle the outside of the rims. The centre lug is consequently in line with the two outer lugs of the next succeeding bucket, therefore each fastening bolt passes through both rear lugs of one bucket, the centre lug of the next succeeding bucket and both wheel rims. If the buckets were detached from the wheel rim and bolted together in this manner, each bucket would form a link of an endless chain. This method of attaching buckets permits the use of fewer and larger bolts and a greater distance between bolt centres than is possible when each bucket is separately attached to the wheel. Where the jet is off the buckets, the strain due to centrifugal force is sustained at a point approximately midway between the two bolts and is consequently distributed equally upon them. When the jet is full on, the strain is sustained equally by the two bolts by reason of the comparatively great spacing between them by this method of fastening. Another interesting feature is that a smaller ratio between jet and wheel diameter may be obtained by reason of the close coupled buckets. Many years of patient experimenting were required to determine the correct curve for the water face of the buckets, while the improvements in nozzles and speed regulating devices were a matter of evolution brought about by the remarkable development in hydro-electric power during comparatively recent years. When Mr. Lester A. Pelton was granted a patent on an improved outer wheel bucket in October 1880 he builded better than he knew.

The Oil Tanker 'Frank H. Buck'

Signs of an industrial awakening on the Pacific Coast have been manifest for some time. Since the great fire of 1906 the bulk of business in the iron trades that was formerly handled in San Francisco has been diverted to eastern manufactories by reason of the inability of local establishments to handle orders. The great handicap suffered by reason of the destruction of patterns and drawings as well as machine tools proved a staggering blow to many of the old established concerns, two of which, following a struggle of several years, gave up business after a record of continuous operation covering a period of over half a century. Labor troubles, resulting in high wages and enhanced cost of raw materials, rendered it still more difficult to recover from the loss of property and diversion of trade to other channels. There is, however, a type of man to whom difficulties only bring about added determination to overcome them. Improved methods of manufacture help to counteract high labor costs while a management that can secure the cordial coöperation of the rank and file of its men has won more than half of the battle. This is what made possible the launching of the *Frank H. Buck* from the ways of the Union Iron Works on February 12. She is an oil tanker of 67,000 barrels capacity and was built for the Associated Oil Company from plans prepared by Mr. Fred Trist. The vessel is 426 feet 9 inches long, 55 feet 4 inches wide, 31 feet 8 inches molded depth, and is built according to

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the Isherwood or longitudinal system of framing, a new idea in hull construction introduced by Mr. Hugo P. Frear, naval architect for the Union Iron Works. The oil storage tanks are 16 in number, each of which is connected to the oil pumps by a 10-inch suction. There are two oil pumps with 18-inch steam cylinders, 15-inch oil cylinders, and 18-inch stroke, of the direct acting duplex type equipped to handle fuel oil, gasoline, and other refined products. These pumps are capable of discharging an entire cargo in about 4 hours. Quarters for the captain and officers are situated in a house on the bridge deck amidships while the crew's quarters, galley, pantry, messrooms, store rooms, and baths are under the poop deck. The steering gear is of the Brown steam tiller type operated by means of a Brown telemotor. A number 3 Shaw & Spiegel towing machine with 1800 feet of steel wire towing line is situated in the poop on a specially built platform. The windlass, as usual, is placed on the forecastle deck, while four steam capstans and two steam winches are erected on deck for handling lines. The propelling machinery consists of one vertical inverted triple expansion marine engine with 26½-inch high pressure, 45-inch intermediate, and 75-inch low pressure cylinders, 48-inch stroke designed to develop 3000 horse-power at 72 revolutions per minute. The condenser is of the cylindrical type with steel shell and has 3755 square feet of cooling surface. The power developed will give the vessel a speed of 11 knots per hour. There are four Scotch marine boilers 14 feet diameter and 11 feet 9 inches long built for a working pressure of 200 pounds per square inch with a heating surface of 9360 square feet. As is usual with oil tankers, the propelling machinery is placed in the extreme after end of the vessel in order to provide the greatest possible oil carrying space. The first steel tanker to be built on the Pacific Coast was the *George Loomis* constructed for the Pacific Coast Oil Company nearly twenty years ago. The *Frank H. Buck*, however, is the first Western-built tanker that is essentially of the new era of oil transportation by sea, so California oil will find its way to foreign ports in a California-built vessel.

OF exceptional interest in connection with the construction of this vessel is the fact that it is the first vessel to be built in San Francisco in direct competition with Eastern yards since the fire of 1906; it is the largest tanker built under the American flag; and is the first vessel built on the Pacific Coast on the Isherwood system of framing. The time consumed in construction has never been equalled for this type of vessel. The first keel plate was laid September 6, 1913, or just 5 months and 5 days before launching, and when it is considered that a tanker is minutely separated into numerous compartments and that the riveting must be of special character to retain oil, the short time of construction is all the more remarkable. The Union Oil Company and the Standard Oil Company have followed suit, each having ordered a tanker of the same capacity as the *Frank H. Buck*. There are upward of 3000 men employed in the Union Iron Works' yard at present, the scene of activity recalling the halcyon days of 1901 when 5000 men were employed and a payroll of $500,000 was distributed monthly. There is a tradition existing in the field of sport that a once defeated champion cannot 'come back.' In this case as in every other field of human endeavor, however, it depends entirely upon the man.

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REVIEW OF THE MONTH

INTEREST in Pacific coast industrial affairs during the month has centred chiefly on the improved condition of the oil industry. Crude oil heavier than 18° Baumé has advanced from 35 cents to 40 cents per barrel. This has been caused by the fact that during the period when the Standard Oil Company declined to make further purchases of heavy oil, consumption gradually overtook production and the large stocks held in the field have been greatly diminished. Not only that, but the heavy investments made by European capital in the California fields during the past few months have given rise to the opinion that a large portion of the production controlled by foreign companies will be exported to European markets. This will remove a considerable portion of the total output from local competition. Drilling has been resumed in many fields and all of the larger companies are adding to their storage capacity. Three large tank steamers are under construction in San Francisco yards, and altogether the business outlook from the oil man's standpoint is more promising than it has been for the past two years.

NEWS of financial difficulties of the People's Water Company, which has been serving the city of Oakland and a number of smaller municipalities in Alameda county with water for domestic purposes, has not come as a matter of very great surprise. It seems from the statements published in the daily press attributed to Mr. Frank C. Havens, that the company has been indulging in land speculation, which to say the least, has proved to be unwise. According to a statement made by Mr. Havens to the California Railroad Commission, the total liabilities of the company are in excess of $44,000,000, of which nearly $20,000,000 is funded indebtedness. With a gross corporate income slightly in excess of $700,000, the situation for the bondholders as well as the stockholders cannot be regarded as very reassuring. It appears from the various reports that large holdings of outside lands have been purchased, for which bonds have been given in payment. There is a marked difference of opinion as to the value of these lands and also as to the propriety of the prices paid. An instance is cited where authorization was given for the purchase of 4197.59 acres of land and one-quarter interest in 2519.66 acres at the price of $605,000, of which $425,000 was paid in bonds and $180,000 in a mortgage assumed by the company. It is stated that the actual value of these lands at the time was slightly in excess of $125,000. A prolific use of short time notes was one of the expedients resorted to in order to postpone the unavoidable day of reckoning as long as possible. There is a long list of note holders for which nearly $6,500,000 in bonds has been used as collateral. The affairs of the company have been placed in the hands of Messrs. John S. Drum, W. W. Garthwaite, and P. E. Bowles, who have undertaken to do what they can to straighten out the tangled financial affairs of the company in very much the same manner as has the committee who is performing a similar office in the affairs of Mr. Haven's former as-

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sociate, Mr. Frank M. Smith. Mr. Drum has placed an approximate value of the property of the People's Water Company as ranging between $17,000,000 and $20,000,000. It is believed that after the committee has succeeded in securing an extension of time from the bondholders of the original companies which were consolidated in the People's Water Company a physical valuation will be made at once and the company will be reorganized and refinanced on that basis.

REFINANCING the Northern Electric Railway Corporation, however, is being conducted on a totally different plane, as this company has been backed financially by the Sloss family, whose name in Pacific coast financial circles has been regarded as one of unquestioned security. At the time the Northern Electric Company was organized by the Sloss Brothers, E. R. Lilienthal, W. P. Hammon, and Eugene de Sabla, the authorized bond issue of $6,000,000 was not sold by reason of the financial stringency existing at the time. In order to go ahead with the enterprise, the bonds were used as collateral, with which money was borrowed on short time notes, the individuals above becoming endorsers of this paper which is now becoming due. At practically the same time, the promotion of Natomas Consolidated and General Petroleum was also being carried on by the same interests. These latter companies have recently been reorganized with English capital. Two days after the great fire of 1906, the Northern Electric Railway commenced operations and it continued during the hard times in 1907 up to the present time and has finally become a self-sustaining property, so far as meeting operating and fixed charges are concerned. The difficulty at present is one of an absence of initial capital. The short time notes are coming due and the bonds used for collateral have not been sold. A refinancing bond issue is about to be undertaken, but as this involves a comprehensive report to be made by J. G. White & Company as consulting engineers, steps necessarily had to be taken to protect both the company and note holders over the time required for making the report. To meet this exigency the Sloss Securities Company has been formed, into which has been turned all of the securities owned by Louis Sloss & Company, Sloss Brothers, and the Northern Electric Railway Corporation, amounting in all to $5,000,000. Another corporation has been formed known as the Sloss Corporation, to which Mrs. Sarah Sloss has turned over $1,500,000 of securities, taking stock to that amount in return. The stock of both these corporations has been transferred to the Union Trust Co. as depositary, under a trust agreement and under the control of five trustees who are also directors of the two corporations. Through the pledging of the Sloss private fortunes these steps have been taken in order to secure all of the note holders against financial loss during the interim that will elapse before the refinancing bond issue will be operative. A circular letter has been issued to note holders with the request that they deposit their notes and collateral with the Union Trust Company under the agreement, while all inter-company obligations will be deferred until the full amount of all the notes has been paid.

ANNOUNCEMENT has been made of the consolidation of the Northern California Power Company and the Oro Electric Corporation, thereby creating a merger possessing an actual power development in excess of 50,000

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horse-power and potential possibilities of about 180,000 horse-power. The Northern California Power Company has plants at Volta, Kilare, Inskip, Colman, and elsewhere at which 50,600 electric horse-power is generated. This company is at present supplying Shasta, Tehama, Glenn, Butte, and Colusa counties with power and light and also operates a number of gas plants. After having absorbed the Sacramento Valley Power Company about three years ago, the company now has 625 miles of high tension transmission and 700 miles of low tension transmission. It has an authorized bonded indebtedness of $10,000,000 plus underlying authorized issues amounting to $3,700,000. Of this amount there are outstanding $3,964,000 bonds of the capital issue and $1,803,000 of the underlying issues. The officers are: Messrs. H. H. Noble, president, and Edward Whaley, secretary. The Oro Electric Corporation has undeveloped power properties on Deer creek and Mill creek in Tehama county and Yellow creek and its tributaries in Plumas county. The total estimated potential development at these points is about 130,000 horse-power. The company is now operating two generating plants on the west fork of the Feather river in Butte county, while a new 50,000-horse-power plant is in course of construction on Yellow creek. The company is serving the Oroville district with electric power and light and new transmission lines were projected throughout central California until the company failed in its application to enter the city of Stockton in competition with the Western States Gas & Electric Company, which is controlled by H. M. Byllesby & Company. Since that time the Oro company has accomplished practically nothing in the way of extension, its great project at Yellow creek having been abandoned after large sums of money had been expended thereon. The officers of the company are: Messrs. J. W. Goodwin, president; L. J. Holton, vice-president; and W. G. Jack, secretary. The authorized capital stock is $10,000,000 and bonds have been authorized in the sum of $10,000,000, of which $1,500,000 is held by the public and the remainder by subsidiary companies, the Oro Development Company and the Oro Water, Light & Power Company.

IT would appear from all present indications that rail transportation in Alaska will soon be an accomplished fact. The Alaska Railway bill has passed the Senate and it is believed that it will be put through the House without important changes. The bill in its present form provides for a $40,000,000 issue in Government bonds and authorizes the President to locate, construct, and operate or lease a railroad system of some 1000 miles in length in the territory of Alaska. A minor portion of this mileage may include such railroads as have already been constructed by private capital, which the Government may acquire by condemnation and purchase. While the exact location has been left to the determination of the President, advised by a commission of engineers, it is the general intent of the bill that the road shall connect one of the open harbors of the southern coast with navigable water on the Tanana and Yukon rivers, Fairbanks being the objective point in the route northward from the coast. An extension is proposed to be constructed from Fairbanks on the Tanana to the valley of the Yukon. It is believed that a decision as to which harbor will be used lies between Seward on Resurrection

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bay, or Cordova on Prince William sound. There are at present two comparatively short lines of railway running inland from the southwest coast of Alaska. There is also a third at Katalla near Cordova and the Bering coalfields. The latter was practically abandoned by reason of insufficient harbor facilities. The White Pass & Yukon railroad, which operates from Skagway to White Horse, has not been considered as a link in the proposed government system, as an extension of this line to the Yukon valley would necessitate the location of a route for a considerable distance in Canadian territory. The present line from Cordova runs northward along the Copper river for 132 miles to Chitina, there turning east to reach Kennecott, near which is the Bonanza copper mine. The Cordova road was built by the Guggenheims and is standard gauge equipped with 70-lb. rail, the name of the corporation being the Copper River & Northwestern Railway. It is assumed that the intention of the builders was to open up coal deposits, but the government policy in this regard prevented its use for that purpose. The Alaska Northern railway runs from Seward for a distance of 71.6 miles northward to Kern creek on an arm of Cook inlet.

CONFLICTING claims for water rights are not of unusual occurrence. It would appear, however, that the city of Los Angeles in opposing the application of Mr. E. G. Ryan for water rights on Rush creek, Mono county, California, desires to embrace an abnormal area within the Owens River water shed. It seems that Mr. Ryan and his associates have filed an application for the use of the waters of Rush creek for the development of electric power for commercial purposes. This application is opposed by the city of Los Angeles on the plea that Rush creek is logically and naturally tributary to the proposed aqueduct power project, although the city has never specifically stated so in any of its filings for water rights. As at present planned, the city has about 175,000 potential horse-power as a by-product of the domestic water supply system. As the Rush Creek development would add but 5000 kilowatts to this at an estimated expense of some $600,000 and involve the probable necessity for constructing some 11 miles of tunnels and 35 additional miles of transmission line to connect with the main line, it would appear to be a very large additional investment with comparatively little offered in the way of benefits. As the peak load in Los Angeles now is something over 60,000 horse-power, an addition of 175,000 horse-power would appear to be sufficient to provide for the increase for some time to come, without taking into consideration additional developments under way for the Pacific Light & Power Corporation, the Southern California Edison Company, and others unless it is proposed to give the city power a monopoly of the southern California load. Curves plotted by Mr. F. C. Finkle show that the railroad load increased at the rate of 9.2 per cent and 6.8 per cent for the years 1912 and 1913, respectively; while the total load for other purposes has been increasing at a rate slightly in excess of 10 per cent since 1911. An additional supply of 175,000 horse-power on this basis would appear to be ample to provide for the increase for the next generation or two. In the meantime, 5000 kilowatts would appear to be hardly worth quarreling over, especially in view of the fact that the expense would be so high for its initial development and utilization.

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Hydro-Electric Developments on the Bear River

By A. E. CHODZKO *

THE utilization of the flow of water by gravity may claim precedence over all other processes of power generation. However, it is true that the hydro-electric industry is of modern origin, inasmuch as the concentration of enormous hydraulic power has been the direct corollary of the developments of dynamic electricity as a means of dissemination of potential energy. Without dwelling at length on the rapid strides made in that direction during the last few decades, it must be admitted that California, which already was the uncontested pioneer in the use of high water-heads for mining purposes, has retained a unique position in the hydro-electric utilization of the natural supply with which it has so abundantly been blessed.

The actual amount of power that can economically be accumulated at a given point is, of course, a commercial factor of paramount importance; yet, with well deserved credit to the huge installations of Niagara, Victor Falls, and others, it may be argued that the problem confronting the engineer consisted in helping himself to an already existing supply of power that had gone to waste from time immemorial for lack of adequate implements to cope with its brutal energy. Nature had previously provided for the formation and filling of the storage reservoir, as well as for the disposal of the water after it had passed below the falls.

Such, however, is not the case in many power development projects, and engineering versatility is taxed to a greater extent when the program includes the creation of a reservoir and the conveyance of its contents through a difficult country to the convenient and oftentimes distant place of its utilization. In this respect, few instances could probably be found covering a more exhaustive use of water 'for all there is in it', than the developments undertaken on the Bear river by the Pacific Gas & Electric Company to meet the increasing demand upon its electric capacity.

Work was started in the early summer of 1912, under the direction of the late James H. Wise, and after his death in the following September, F. G. Baum, was appointed chief engineer in charge of the entire department. Water was turned on at the Drum power plant, the first in order of operation, on Thanksgiving Day, 1913. The entire project contemplates the use of the same water in six consecutive plants before it reaches the Sacramento valley, where it becomes available for irrigation and domestic uses.

The following notes refer to the completed portion of these extensive plans; and when it is considered that from December to the middle of May, tunnel work alone could be carried on, the amount of work accomplished without

*Consulting Engineer, Phelan building, San Francisco.

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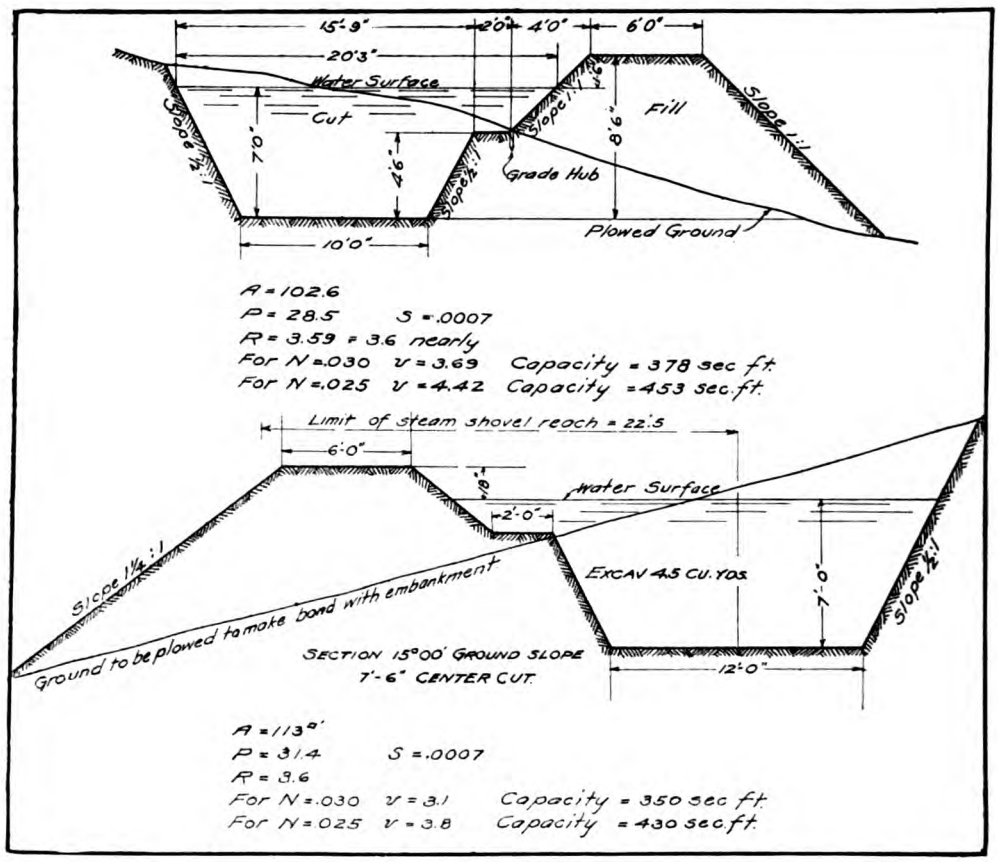
serious accident to the large force engaged is a source of gratification to those entrusted with its execution.

The writer has been intimately connected with these developments from the time of their preparation to the day of their partial completion.



CROSS SECTIONAL VIEWS OF BEAR RIVER CANAL EXTENSION NEAR AUBURN.

The Drum and Spaulding Development*

The Spaulding dam, now nearly completed, is situated on the south fork of the Yuba river about 30 miles above Colfax and 1½ miles north of Smart, the nearest station on the main Ogden line of the Central Pacific railway.

Lake Spaulding receives the run-off from a watershed of 121 square miles, upon which the Pacific Gas & Electric Company controls 20 other lakes, all tributary to Spaulding. The new dam, when built to its ultimate height of 305 ft., will triple the present storage capacity of this South Yuba system, which has in the past supplied water for domestic and irrigation purposes to Placer and Nevada counties, besides generating an average of 1600 kw. at the Deer Creek power-house.

The increased storage will give at the Drum power-house, where the Spaulding water is first used, an average of 28,000 kw. with a drop of 1375 ft., besides an additional average supply of 55,000 kw. which will ultimately be developed by utilizing a further head of

*By R. G. Clifford.

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2600 ft. in five other plants arranged in a series, and each controlled by regulating reservoirs permitting independent operation.

The new Spaulding dam is situated one-half mile below a 60-ft. structure built in 1892 of dry rubble with a timber facing on the water side, across the Yuba at its exit from Lake Spaulding. The storage capacity is increased from 5400-acre ft. to 43,600-acre ft. by the present 225-ft. dam, but this will ultimately be carried to 97,000-acre ft. by raising the dam to its ultimate height of 305 ft. This dimension was adopted after careful consideration, and on the advice of such eminent authorities as John R. Freeman, consulting engineer, and Arthur P. Davis, chief engineer for the U. S. Reclamation Service. It was based on the greatest development of the total run-off from that watershed and it will allow of preserving, in years of mean low precipitation, the total season's run-off, the basis used being the average of a constant draft of 350 second feet.

On the other hand, the cost of the dam per acre foot of storage increases very rapidly beyond that height. The walls of the narrow gorge across which the dam is built are of solid granite, still showing the marks of the glacial period, and remarkably free from seams or other evidences of disintegration. In fact, no excavation was required for the foundation, besides cleaning the sand and gravel from the water-worn pot-holes in the river bed, and removing by means of a sand blast the organic matter adhering to the rocks. This left a clean, fitted surface excellently adapted to afford an intimate bond with the concrete. That narrow canyon offered an ideal location not only by reducing to a minimum the amount of masonry required, but also on account of the horizontal downstream convergence of its sides which caused the water pressure to wedge the dam between them, and to determine in its arched form normal reactions to the abutments and the exclusion of shearing stresses.

The variable radius type of arched dam was chosen, because of the economy it affords in the bulk of materials; the fact that the shorter the radius and the thinner must be an arched wall for a given strength, militates in favor of a reduction of that radius, a tendency moreover limited by the width of the gorge, and by the desirability of keeping a uniform batter at the upstream face.

In the 225-ft. dam now completed the radius varies from 250 to 400 ft. and would reach 440 ft. with the extension in height to 305 ft., but was provided for by stepping and reinforcing the downstream face. The saving realized in the yardage of concrete by that design was about 25 per cent.

A 7 by 9-ft. drainage and inspection gallery was left in the masonry clear across the dam a short way above bedrock and 30 ft. from the water face. Protection against uplift pressure by leakage is afforded by two parallel tiers of 6-in. vertical drains, 8 ft. apart in each tier and staggered, running from the foundation up and from the top down to the drain tunnel. In addition, radial joints or lines of weakness, spaced 80 ft. apart, are purposely carried clear through the dam, but dovetailed, so as not to detract from the ultimate strength in any way. A vertical recess filled with asphalt near and all along the upstream edge of these joints insures a proper plasticity without permitting more than a nominal amount of leakage. This is intercepted at the drainage gallery which has, of course, an exit to the downstream face.

The material used in the dam is a

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gravel concrete, the large natural gravel deposits in the Bear river near Colfax furnishing a better and cheaper material by, at least, $0.60 per cubic yard than sand and crushed granite quarried on the job. In the lower portion of the dam, large fragments were embedded in the concrete in the proportion of 18%, but higher up the placing of these plums became too expensive and was discontinued. The mix near the base is 1 part cement to 7 parts gravel, but in the upper portion of the work, where stresses are heavier, it was changed to 1 : 6, giving an ultimate compressive strength of 1600 lb. per sq. in., determined by daily field tests of the concrete used in the dam.

Spillways.—In addition to the main dam it was necessary to construct two smaller ones a short distance to the north, both of which will be used to pass the flood waters. These are simple radius arch type structures with low stresses, their respective lengths being 105 and 90 ft., with heights 20 and 15 ft., and provision made for 5-ft. wooden flashboards. Their capacity in conjunction with 100 ft. of spillway on one end of the main dam is 9000 cu. ft. sec. which is 100% in excess of the record flood of 1907.

When the main dam is raised to its ultimate height these two secondary structures will be carried to 100 and 95 ft. respectively, and two additional smaller dams 60 ft. high will be necessary; the one nearest the main dam, with a crest 500 ft. long, will then be used as the only spillway.

MASONRY LINING OF A PORTION OF DRUM CANAL.

Outlet Tunnel from the New Lake Spaulding

Most of the 390 cu. ft. sec. available is carried by an aqueduct about 9 miles from the Spaulding dam to a forebay hollowed out on the top of a ridge 1375 ft. above the power house situated in Bear river. A study of the U. S. Geological Survey map of the Colfax quadrangle indicates that the Bear river heads at a point near Emigrant Gap

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where the South Yuba makes a sharp turn of some 90° to the north and the stored water of Lake Spaulding is carried over by tunnel and canal away from the South Yuba and along the slope of Bear valley.

The old South Yuba system also carried the water from Spaulding over into Bear valley, but by means of a wooden flume built along precipitous bluffs some 135 ft. lower than the present aqueduct.

EXTERIOR DRUM POWER HOUSE.

Outlet Tunnel.—The tunnel, which has a total length of 4456 ft., starts from a point in the granite bluffs some 45 ft. from the face of the dam and two slight horizontal angles were found necessary to keep the maximum amount of ground overhead and at the same time to provide for an adit 1100 ft. from the tunnel entrance. This adit, 100 ft. long, made it possible to work the tunnel from four headings instead of two, thereby hastening the work materially. The minimum amount of solid rock over the tunnel roof at this point is 55 ft. This adit will also be utilized as a relief opening and spillway in connection with a turbine installation which will be described later on.

The elevation of the tunnel involved the analysis of several variables. The amount of storage lost should be a minimum, but the head available for power should be as great as possible. The slope of the tunnel and canal should be as flat as feasible to save the power head, but must be influenced by the cost of construction. The curve of pond storage shows only 190 acre-feet in the lower 70 ft. of the reservoir and this 0.2% is almost negligible in comparison with the value of the head gained. The slope of the tunnel was taken as 7 ft. per mile and the circular section 8 ft. 8 in. diameter was designed to carry 450 cu. ft. sec. when lined

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with concrete having a coefficient of friction **n** of 0.013 and running within a foot of the top.

After construction was started it was decided to put the operating valves at the adit instead of at the entrance and utilize the variable head of the reservoir for power by installing a 5000-kw. turbine, which in conjunction with two relief valves would economically utilize the vast amount of energy stored in the reservoir.

The tunnel as constructed is a pressure tunnel from the entrance for a distance of 1000 ft. to the turbine installation, (the adit furnishing a surge outlet) and from there on is an unlined tunnel 10 ft. in diameter capable of carrying 260 cu. ft. sec. with no back pressure and 400 cu. ft. sec. with only about 6 ft. back pressure at the upper end. The small amount of power lost by this back pressure would not pay for enlarging, nor for lining the lower end of the tunnel.

Construction Equipment.—No very unusual methods of tunnel driving were employed, but very rapid progress was made and several varying schemes were used which should prove of interest to the technical student who may be called upon to handle work of similar character. The main compressor plant situated just above the south end of the dam furnished air to the upper portal and two adit headings beside the quarry, dam excavation, and blacksmith forges. For this purpose two Ingersoll-Rand, two-stage, duplex air-compressors were used, rated at 704 cu. ft. of free air per minute when compressing to 100 lb. and running at 150 r. p. m. They are called Imperial X B-2 compressors and are self-oiling machines, needing only one attendant per 12-hour shift, who also acts as sub-station operator. These compressors were each driven by a 125-hp. alternating current motor and by interconnecting the piping, a single 4 by 12 ft. receiver was sufficient for both compressors. A 4-in. standard pipe line conveyed the air to the tunnel headings where it was reduced by means of a manifold for connecting to the short lengths of 1-in. armored air hose operating the drills. The drills used at the upper portal and adit were 3¼-in. Ingersoll 'butterfly valve' type known as 'E44,' while a similar drill made by the Sullivan Machinery Co. (U F-2 type) was used at the lower portal. Little difference in operation or maintenance between these two makes of drills was observed. At the lower portal a separate compressor plant was installed consisting of two 13 by 7 by 18-in. two stage compressors used formerly at the company's Martin station. These second-hand machines were somewhat more costly as regards repairs, but stood the heavy work required in fairly good shape.

Ventilation was provided by means of 6-in. Sturtevant centrifugal blowers, belt driven by a 5-hp. 3-phase induction motor, the air being conducted through 12-in. No. 10 B. & S. gauge iron piping to a point 150 ft. from the heading.

The lighting is done with 110-volt circuit, three wires of the 3-phase lighting circuit being carried in 1-in. pipe conduit and a tap made at about 30-ft. intervals. The lights would tap alternate pairs of wires so that all the lights would not be extinguished should one wire be cut or broken.

The haulage of muck and drill materials was accomplished by means of horse and man power, using a 16-in. gauge track of 12-lb. rail and 20 cu. ft. mining dump cars.

Progress of Work.—The average date of starting the four headings was August 17, 1912, and the upper headings met December 26, the total progress for this 131 days being 2563 ft., or 19.6

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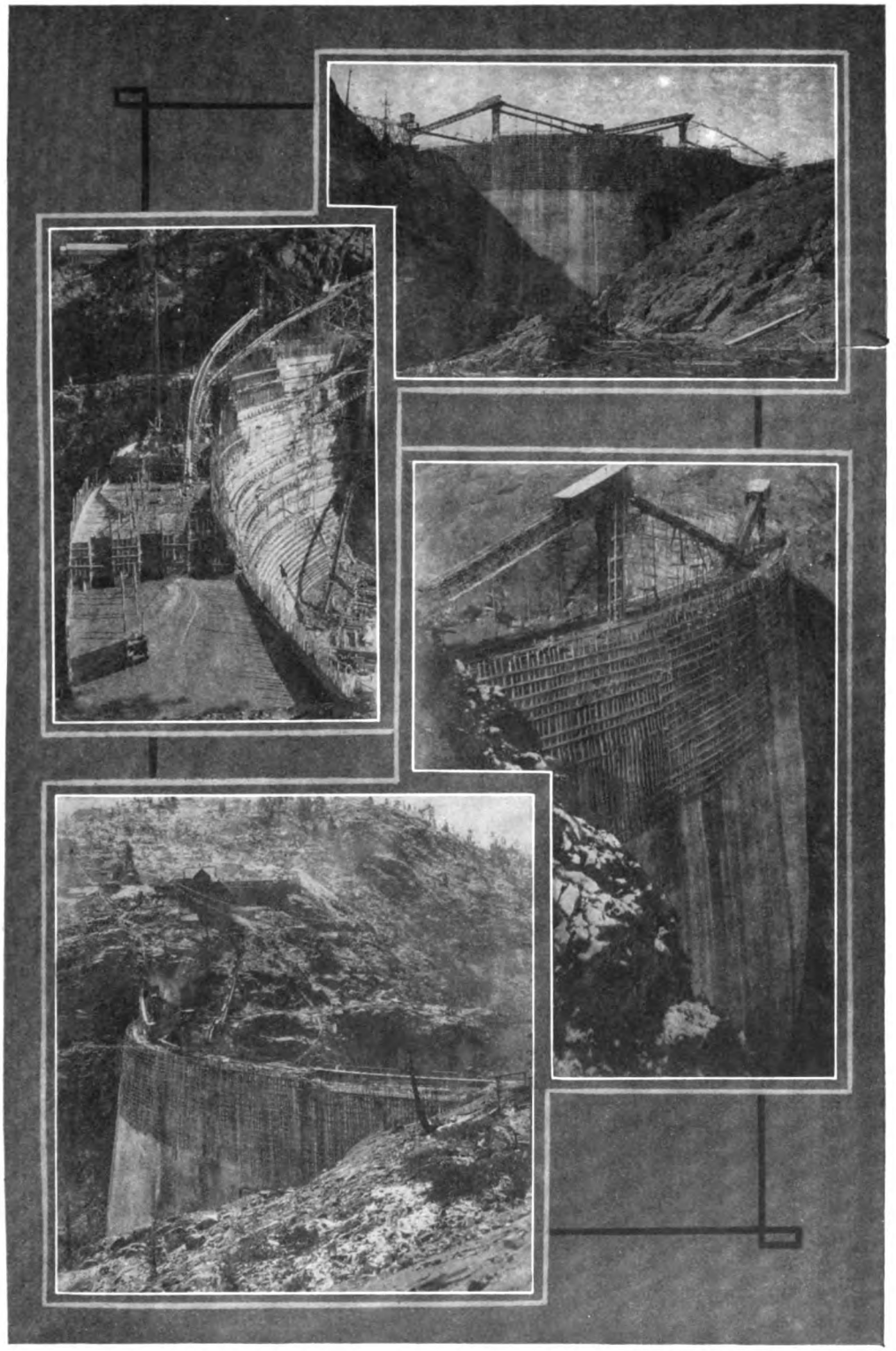

VIEWS OF LAKE SPAULDING DAM IN VARIOUS STAGES OF CONSTRUCTION.

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ft. per day and an average of 4.9 ft. per heading; but as a single crew worked the two headings on either side of the adit the daily progress for each crew was 6.5 feet.

The remaining 1895 ft. of the tunnel, worked from two headings, was completed by May 2, 1913, or 126 days time, the average daily progress per heading being 7.5 ft. The best monthly progress for one crew was made in December by the men at the adit, working alternate headings when 445 ft. was driven in 30 working days, or 14.8 ft. per day. In November an average progress of 14 ft. was made. For a single heading these same men drove 10.4 ft. per day during February and here it is well to call attention to the much greater economy possible when two headings can be worked from a central working point, by either shaft or adit. Upon the time that can be devoted to drilling rests the progress of the work and with a single heading the 24 hours of operation with three shifts usually averaged about as follows: 1 hour setting up, 6½ hours drilling, 1½ hours loading, shooting, and clearing away of smoke, 3 hours mucking back, and the same round of operations for the next twelve hours. With the two available headings the drills can be dismounted and set up in the other heading while the loading is going on, then only about ½ hour is lost during shooting and the 6 hours in 24 lost while mucking back can be utilized in drilling, thus the operation would be as follows: 1 hour setting up, 6½ hours drilling, 1½ hours again setting up and clearing away of smoke, another 6½ hours of drilling, etc., thereby giving three rounds per day instead of two which demonstrates the difference in our actual progress for the two cases 14.8 ft. against 10.4 feet.

The tunnel driving at Spaulding was carried on through the winter and much credit is due those in charge, as well as to the tunnel crews, that few interruptions occurred in spite of the fact that 15 miles of temporary transmission line had to be kept in repair, supplies hauled two miles, and trails kept open during several months of snow averaging 6 ft. on the level. Several dangerous snow slides blocked the work at the upper portal and adit and falling trees put the transmission line out of commission occasionally.

Owing to scarcity of men and drill steel at times, it was not possible to keep three shifts going all the time. The average progress per 8-hour shift throughout the whole time was 3.1 ft. The average depth of the 14 to 20 holes used per round was 5.6 ft. of which about 82% or 4.6 ft. was broken.

Driving Methods.—No unusual methods were employed in drilling. The material, a granodiorite was very hard but broke well and for the most part was rather seamy, giving an over-break of 15%. The number and location of the holes upon which depend the successful breaking of each round vary according to the tightness of the ground. In places 14 holes would break out the heading perfectly and again in hard spots even 20 holes had little effect on the material.

Two, three, and four drills were employed at the different headings at varying times and while the four drills (two on each column) made the fastest progress, the cost per foot remained very much the same in each case. Three drills each with a separate column would give the best economy if it were not for the cramped quarters of a tunnel of this size. A cross bar instead of a vertical column has the advantage of saving time in that it can be set up before mucking back from the face is complete. The reason it was not employed at Spaulding was that many

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TAHOE SIPHON, PART OF DRUM AQUEDUCT.

tunnel accidents have occurred with the use of cross bars, a misfired lifter or bottom hole being overlooked, due to the presence of muck, until a drill strikes the powder. Be it noted to the credit of the foremen in charge, that not a single life was lost during the nine months of tunnel driving and but one accident of any consequence.

The powder used was not the same at each heading; at the lower portal 40% of No. 2 dynamite and 60% of No. 1 was employed and this combination worked admirably and at an average cost of $3.70 per ft. for powder, cap, and fuse. At the other headings No. 1 powder was used altogether, the cost per foot being about $4.10. As the headings were advanced, however, the rock became tighter and it was found advisable to use a powder containing 80% nitro-glycerine instead of No. 1 which contains but 60%. This 80% powder is a gelatine dynamite and is no more dangerous to handle than 40% nitro-glycerine dynamite and the absence of obnoxious fumes makes it especially adapted to underground work. The extra cost of this higher explosive is made up entirely by the fewer holes needed and certainly of breaking the round well back toward the end of the holes.

Little water was anticipated and only two or three minor springs developed, most of the water occurring in the lower end and where the grade was sufficient to carry it away. A small duplex pump and 1½-in. pipe handled the water in the heading south from the adit.

Lining.—One of the greatest difficulties confronting engineers today is to carry water in a large pressure tunnel safely and at a reasonable cost. Pressure tunnels are being extensively employed on the Catskill aqueduct and on several other large projects and the Los Angeles aqueduct also had an example in its Sand Canyon siphon whose failure was described in the technical press.

At Spaulding there is not the very

DRUM SIPHON, JUST BEFORE ENTERING FOREBAY.

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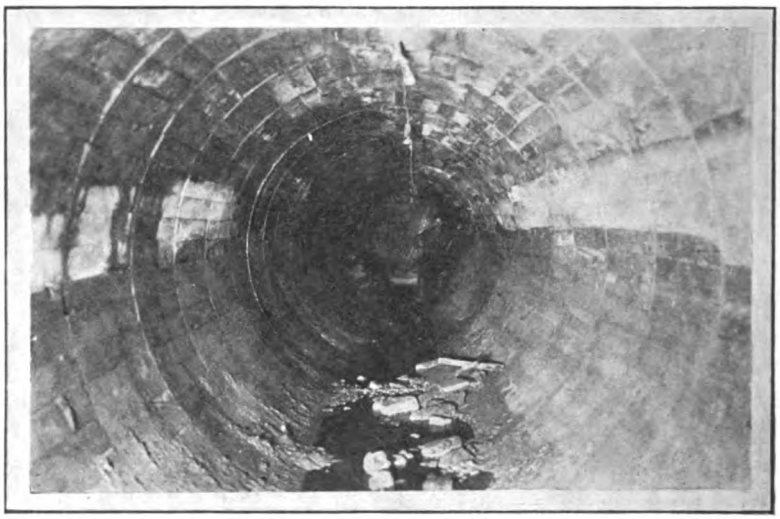
high pressure that must be provided for in the cases referred to above, but the 100 lb. per sq. in. obtaining in our case would require ½-in. steel pipe for the 8 ft. 8 in. diameter of the tunnel. If this solid pipe was installed it would mean additional expense in enlarging the tunnel for riveting and would make the total cost almost prohibitive. One of the safer methods followed in portions of the Catskill aqueduct not deep underground, is first to construct a reinforced concrete shell, inside which is placed a thin sheet steel lining which in turn is coated with a thin layer of mortar to prevent rusting. In the deeper tunnels 15 to 18 in. of concrete without reinforcement is used, behind which is forced grout under 150 to 200 lb. pressure through grout pipes left in the concrete. In this case the material through which the tunnel is driven carries a large percentage of the bursting stress of water, even should there be no leakage through the concrete. Since it is well known by experiment that a high pressure (over 75 lb. per sq. in.) will produce a very considerable leakage through concrete of thickness practicable for tunnel linings, it is evident that if any pockets or seams of any description exist behind the linings, the full pressure of the water in the tunnel will ultimately be transferred to these pockets or seams. In the case of the sand siphon referred to, the tunnel itself was not apparently damaged except as to innumerable tiny cracks, but the layer of seemingly solid granite transferred this pressure outward until at last the whole hillside burst.



CONCRETE LINED TUNNEL LEADING FROM DAM.

With this in mind the pressure tunnel at Spaulding is heavily reinforced for that portion where there is the slightest possibility of water leaking through to the outside, so should a blow-out occur, the tunnel will still be able to carry the full pressure without exceeding the elastic limit for the steel reinforcement.

Pressure grouting is also resorted to, that there may be a minimum chance for air pockets to accumulate the pressure.

The project as a whole was started

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STEEL 'SNOW' TOWER.

on July 3, 1912, and the power plant was in operation by Thanksgiving Day of 1913. At that time the dam had been completed to a point 235 ft. above the foundations which furnishes sufficient storage for present power needs.

Operating Mechanism.—The regulation of the water flow from Spaulding reservoir will eventually be effected by means of the variable head turbine previously described; for the time being, two Allis-Chalmers No. 12 pressure regulators, each of a capacity of 300 cu. ft. sec. under 30 ft. head will by-pass the water around the turbine chamber. Either of them can be cut out by a 48-in. butterfly valve of the same make. Emergency valves are installed close to the intake and to avoid working these 72-in. butterfly gates under a high head, a 45° raise was driven back from a point 200 ft. from the intake of the pressure tunnel, and this taps the reservoir 100 ft. above that intake where the lower emergency gate is situated. The latter will then be only under a unit pressure of 55 pounds. These emergency gates are approached by tunnels connecting with a vertical shaft sunk from the 4815 level (the tunnel being 4670) and also with the inspection tunnel in the dam.

A 36-in. sluice valve at level 4635, discharging through the dam into the exit from that inspection tunnel, permits of draining the lake for repairs at the emergency gates or for getting rid of material accumulating against the dam.

Canal.—The water issuing from the tunnel is carried through an open canal of varying cross section with occasional short portions of wooden flumes or of stave pipes and steel siphons to Drum forebay, a distance of 8.7 miles.

The first ½ mile has a grade of 1 in 800, a bottom width of 14.5 ft., side slopes ½ to 1 and with a full head of 6 ft., a top width of 20.5 ft. Approximately 50 cu. ft. sec. will be diverted at the end of this section by means of a spillway followed by a steep flume leading to the existing canal to Deer creek and other points in Nevada county. The balance of the canal has a grade of 1 in 1000 and the cross section is 11 ft. wide at bottom, 18 ft. at top, and is 7 ft. deep with slopes 1.2 to 1.

An economical and satisfactory lining has been used at the upper half of the canal, where the ground is porous and the slopes insecure, by laying up the excavated rock as dry rubble to the high water line and below that level in the impervious portions; the remainder is lined with rubble masonry laid with 1 : 3 mortar, costing about half as much as concrete for a corresponding yardage.

Flumes.—The flume sections, of which there are 1800 ft., are used in crossing Bear river and several small

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hollows where the canal would have been insecure. A stretch of several hundred feet crosses a gap in passing from the north to the south side of the ridge; 700 ft. have a section 11 by 6 ft. and 1100 ft. a section 9 ft. 8 in. by 6 ft. 6 in. with the same slope as the canal, the capacity being 380 cu. ft. sec.

Siphons.—The Tahoe siphon, 1874 ft. long, was necessitated by the inability to secure a right of way free from unreasonable obligations; it circles between two points 1500 ft. apart on the canal grade. The material used consists of 1029 ft. of 96-in. and of 417 ft. of 94-in. redwood stave pipe, carried on wooden cradles above ground, and of 427 ft. of 84-in. steel butt strap riveted pipe ⅜-in. thick. Maximum head for the wooden stave pipe is 191 ft. and for the steel pipe 237 ft.; single concrete boxes connect the wood stave pipe to the canal.

Another siphon crosses a saddle close to the forebay under a maximum head of 128 ft. It consists of 1888 ft. of 102-in. riveted steel pipe, 5/16 in. thick throughout, both ends connecting with concrete header boxes, and the intake protected by a grizzly or trash rack. A few hundred feet of canal 15 ft. wide and 6 ft. deep extends from the siphon's outlet to the forebay.

Forebay.—This equalizing reservoir at the head of the penstocks is situated on top of a ridge overlooking the power house and extends as far around as was possible. The fact that the gently rounded top of that ridge was 50 ft. higher on one side than on the other explains why the forebay is half excavation and half fill. The pond area when full is 13 acres, the available depth 34 ft., and the total available capacity 434 acre-feet, sufficient to furnish the average flow of 350 cu. ft. sec. for nearly 15 hours, should a break occur higher up, and more than sufficient for regulation between daily minimum and peak loads under extreme conditions. The filled portion is formed of an earth dam 12 ft. wide at crest, with water slope 3:1 and back slope 2:1 near the base and 1½:1 on the upper 30 ft. The greatest height of embankment is 54 ft., the third of the dam nearest the water being made of carefully selected material with sufficient clay to be practically impervious, while the more porous material was kept in the back to allow for free drainage of any leakage. All of it was placed in concave layers and thoroughly compacted while damp to prevent subsequent settlement; the upper half of this enbankment is faced with rock riprap to protect against erosion by wave action.

Should the forebay require emptying for repairs or cleaning, the water may be by-passed from the canal proper to the penstocks through a section of canal excavated along one side of the reservoir. A 24-in. steel drain pipe discharging into Canyon Creek reservoir passes under the embankment at the lowest point, concrete collars and careful hand-tamping precluding leakage around it. A spillway is provided in the last section of canal between the siphon and the forebay to prevent the possibility of overtopping the banks of the latter; this spillway water will flow down into Bear river for the next development.

Penstocks.—The depressed converging concrete approach to the penstock pipe is fitted with a trash rack and leads the water into a 72-in. riveted steel pipe which passes through a tunnel 328 ft. long under the solid portion of the forebay. This pipe is fitted with a 72-in. Allis Chalmers butterfly valve situated just outside the forebay tunnel.

The total length of the penstock is 6194 ft., the maximum static head with

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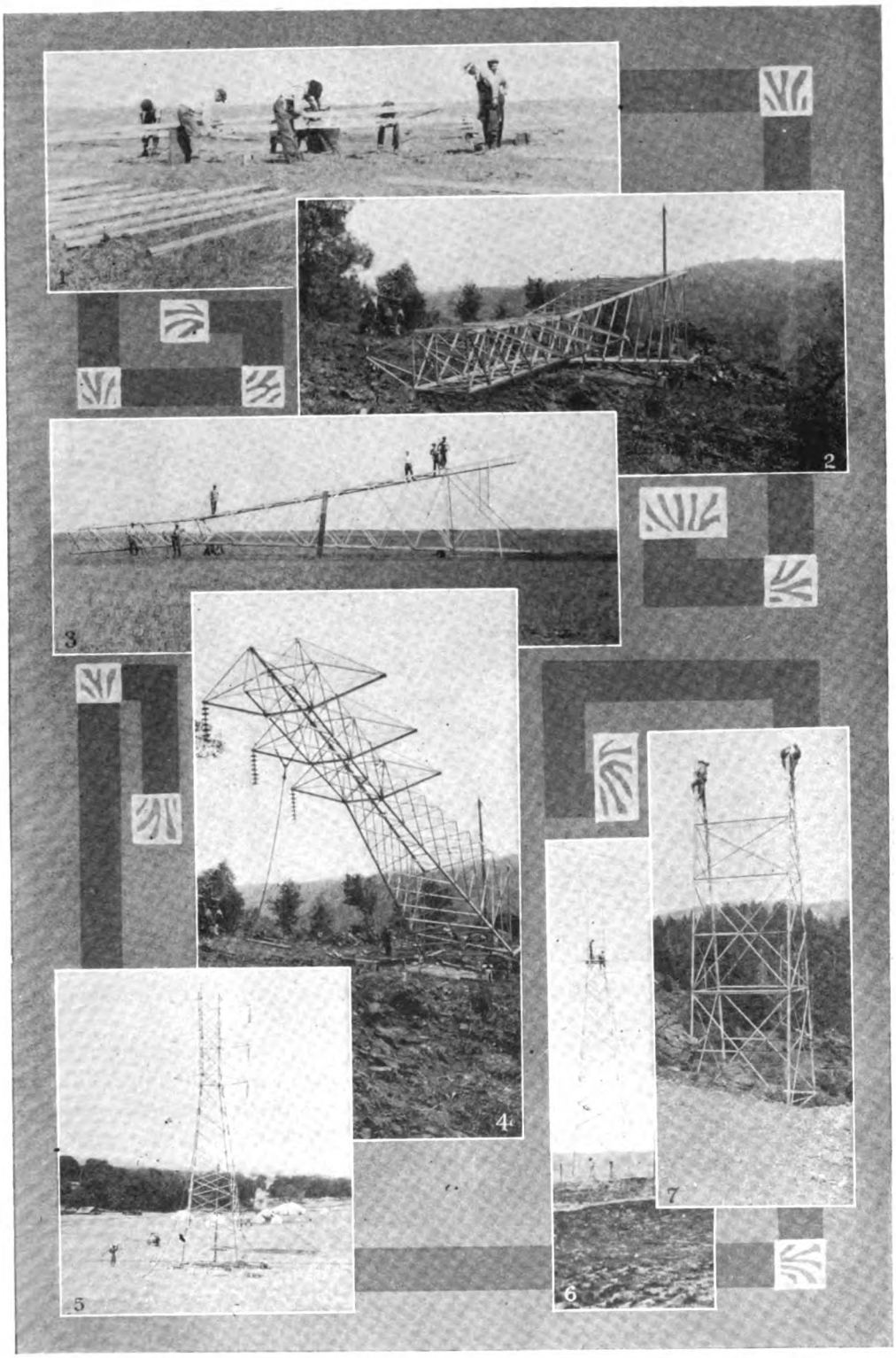

VARIOUS STAGES OF TOWER CONSTRUCTION FROM ASSEMBLING OF PARTS TO COMPLETION.

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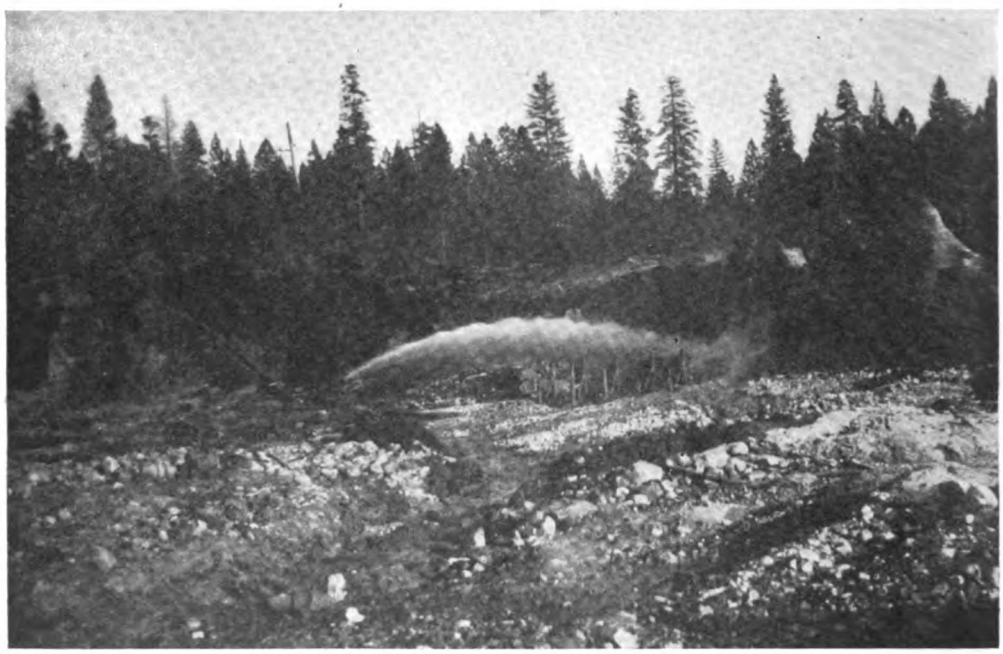
the reservoir full being 1375 ft. The first 4000 ft. extends along a ridge and drops only 260 ft. below the forebay. the length of heavy steel being proportionately small.

Following is the detail of this pipe line:

Diameter. Inches.	Thickness of metal. Inches. Lap riveted.	Length of section. Feet.	Max. static head. Feet.
72	¼	665	174
72	5-16	797	213
72	¼	980	174
72	5-16	350	213
72	⅜	480	258
	Butt strap.		
72	⅜	730	329
72	7-16	65	352
66	7-16	244	410
66	½	123	457
66	9-16	119	509
66	⅝	103	559
66	11-16	97	612
66	¾	82	655
60	¾	114	719
60	13-16	153	793
60	⅞	96	838
60	15-16	98	895
60	1	71	937
54	1 1-16	97	994
54	1⅛	99	1052
54	1 1-16	91	1106
54	1⅛	113	1164
54	1 3-16	117	1230
54	1¼	116	1302
52	1¼	194	1374

A standpipe is provided at the forebay just below the emergency butterfly valve, and six 6-in. air valves are



WASHING GRAVEL BANK WITH HYDRAULIC GIANT TO PROCURE GRAVEL FOR TOWER FOUNDATION.

placed at the three main changes in vertical slope along the pipe line, to admit air and to prevent collapse should a break occur in the penstock. This point has received careful attention and the most severe combinations. of simultaneous opening or closure of the nozzles at one end and of the butterfly valves at the other, have been vigorously scanned in designing that portion of the plant. At the power house the 52-in. pipe branches into two 36-in.

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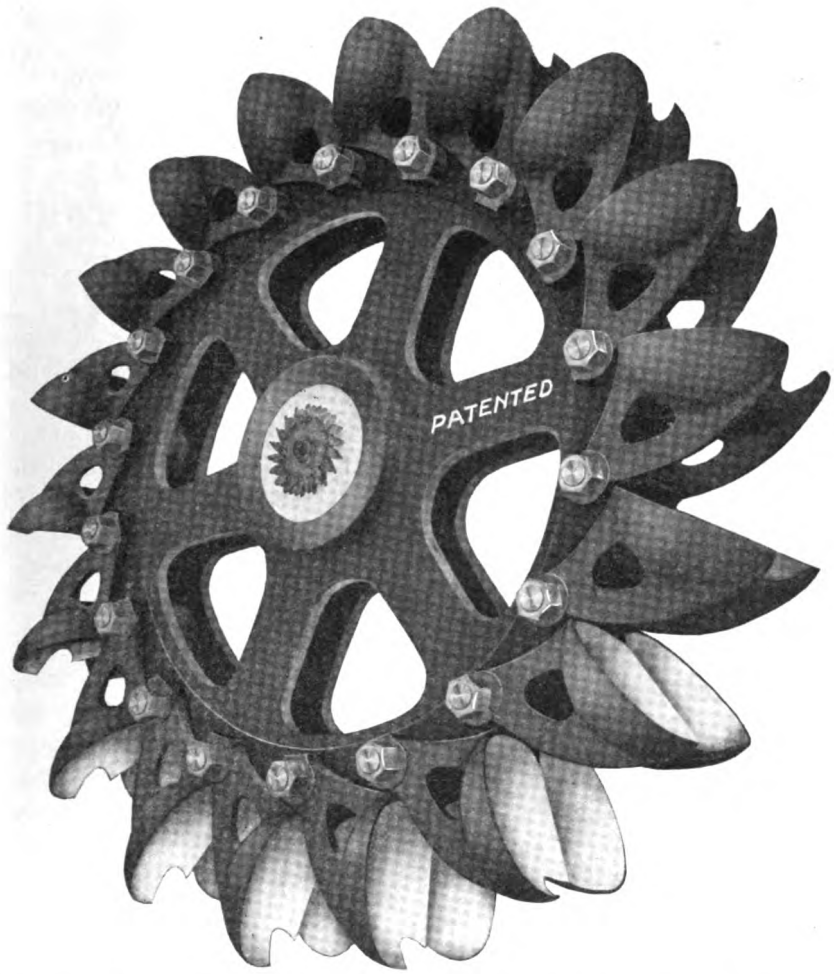
pipe, each provided with a straightway gate valve tested at 1000 lb. pressure and made by the Pelton Water Wheel Company.

Power House.—The Drum power plant is housed in a substantial fire-proof building with steel frame and reinforced concrete walls and roof, which offers a happy blending of artistic design with a utilitarian object. Provision has been made for duplicating the present installation, the dimensions being 208 ft. 8 in. by 77 ft. 6 in. with a height of 65 ft. Two 50-ton electric cranes travel along the main aisle above the generators, governors, and transformers. On the first gallery floor are placed the switchboard, and the low voltage oil switches, while on the top floor and separated from the rest of the building by a concrete curtain wall, is the high tension gallery.



DOUBLE DISC PELTON-DOBLE WATER-WHEEL RUNNER WITH INTERLOCKING BUCKETS.

Equipment.—The main generators, of which there are two, are 12,500-kw., 6600-volt, 3-phase, 60-cycle, 20-pole, 360-r.p.m. machines made by the Westinghouse Electric & Manufacturing Co. The shaft in each is horizontal

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and a 9000-hp. water wheel, made by the Pelton Water Wheel Co., is overhung at each end of it. Each wheel is driven by a single jet, controlled by a needle valve, and of a maximum diameter of 6⅞ in. A Lombard governor for each generator controls simultaneously the nozzles of the twin wheels.

Transmission Line.—A single 115,000-volt line is carried on steel towers from Drum power-house to Cordelia, a distance of 109.5 miles. The first 12.6 miles is over a rough mountainous country where severe snow conditions obtain. Special single circuit towers, 50 ft. high and about 500 ft. apart are used in anticipation of snow loads, with wires spaced 10 ft. apart horizontally; these are designed to stand unbalanced loads on adjoining spans. On the remaining 96.9 miles, snow is practically unknown and double circuit towers are used, 82 ft. high and 800 ft. apart. The two circuits are placed on opposite sides with a vertical spacing of 10 ft. in each; special towers of greater height are built when crossing other high voltage lines or navigable streams.

For 30.8 miles from Drum, namely until well out of the Sierra Nevada mountains, where the spans are long and irregular, also for the last 20.7 miles, where in addition to this, sea fogs are encountered, the conductors are 3/0-7 strand copper. For the intermediate 58 miles, across the Sacramento valley, they are 5/0-19 strand aluminum. At Cordelia, the high voltage lines terminate at a substation where the current is stepped down to 60,000 volts and passes on to the existing system.

The complete building of reinforced concrete will be 256 by 82 ft. and 43 ft. high. The equipment consists of two banks of 3-4000 kw. single-phase Allis-Chalmers oil and water cooled transformers, space being provided for two additional main banks and a large amount of auxiliary equipment which will be installed at some future time.

British Columbia Dry-Docks

THE plant of the British Columbia Marine Railway Co. at Esquimalt was, on February 1, transferred to A. V. Yarrow & Sons, the former Clyde shipbuilding firm of Scotland, for approximately $1,000,000.

Official announcement is made by Hon. Robert Rogers, Minister of Public Works, that the Dominion Government has decided to purchase the site on Lang's cove, Esquimalt, for the construction of a new $4,000,000 dry-dock, capable of handling the largest ocean liners and dreadnoughts afloat.

With this announcement comes the almost equally interesting news that the Yarrow shipbuilding firm has decided to establish a branch of its yards at Esquimalt. The construction of the new dry-dock along with the establishment of the Yarrow yards will give a tremendous impetus to the shipbuilding industry on the coast.

The land transferred by Messrs. Bullen comprises 8 acres, with all the plant, marine railway docks, shops, and works of every description, including the complete shipbuilding and repair yards. Messrs. Bullen retain their holdings of the British Columbia Salvage Co., and also the Vancouver branch of the British Columbia Marine railway. The contract for the erection of the great dry-dock, one of the largest in the world, no less than 1150 ft. long, will be let at an early date.

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The Administration of the Public Oil Lands*

SINCE 1909 large areas in the California oilfields have been withdrawn from entry and while there is some question as to the force of the early withdrawal orders, and much difference of opinion as to the terms under which the withdrawn lands should be thrown open to entry, there is no question but that a change from the old system of location and entry is certain. There has been much curiosity as to the attitude that would be taken by the President and his advisers; all the more keen since the present administration has shown marked ability in the matter of obtaining from Congress legislation along lines recommended by it. The first official pronouncement on the subject was that of Mr. F. K. Lane in his recently issued report as Secretary of Interior. He there takes strong ground in favor of a leasing system, not only for oil, but for coal, potash, and phosphate lands. In connection with his discussion of coal lands he formulates the principles that should be followed as below.

These fields should be opened not to speculators but to operators. Those should have these lands who will use them. None should be opened as a basis for a gamble in future values. If these premises express a sound public policy, there appears to me but one conclusion that can be reached as to the manner in which they may safely be turned over to the public—under a leasing and royalty system similar to that under which the state of Minnesota leases its ore lands and the states of Montana and Colorado their coal lands. The tracts opened should be disposed of to those who within a certain time would develop mines and make their product commercially available. This means that where a railroad is necessary to the operating of a mine the applicant should take a lease so conditioned for a limited period. Sufficient land should be leased as a body to justify long-continued and economical operation. As the average of all operations in the United States is 2600 acres, including many small holdings, this might be taken as a maximum unit.

There has been much dispute between those who favor making a lease for an indeterminate period, dependent alone upon continued operation, and those who believe it wisest to fix a term for the lease, 20, 30, or more years. This dispute seems to me of much more academic than practical interest. There should be no disposition to change the lessee. If a fixed term of lease is decided upon, the original lease should have an assured preferential right to a renewal until the mine is worked out. So that in the end the fixed term is a reservation of the right on the part of the Government to make new terms at the end of a number of years, a reservation which could be fixed in an indeterminate lease.

A fixed minimum annual royalty would conduce to operation and prevent the holding of lands out of use. These are matters, however, of regulation upon which much thought should be expended, and the experience of

*Staff article.

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other lands will be found helpful. If the principle of the homestead law is adopted, and one lease only permitted to any one person or group of persons, and all leases made non-transferable, excepting with the consent of a designated authority, it would seem that monopoly could be prevented. I would, however, add one other precaution—that in each field a large body of the coal land be reserved, so that the public and the Navy might be rendered independent of private supplies if that should become necessary.

The attraction of a leasing system is that it enables an operator to put all of his capital into the promotion of his enterprise, no investment being needed for the purchase of the land. This makes it possible for the man of comparatively small means to become a coal mine operator. The lessee is pleased to pay the Government a royalty in lieu of tying up a large amount of capital in the land itself.

The Secretary believes that this system should be applied not only to the coal fields of Alaska but to those remaining in the public lands of the United States. As to oil lands his specific recommendations are as follows:

The United States is beginning to appreciate the extent and value of its oil deposits, and for the disposition of these lands no better plan has been suggested than one analogous to that offered as to coal lands. I would call your attention to the absurdity of applying the placer mining law to the development of petroleum lands. This law, which was based upon the fundamentals of the miners' codes of early days, was passed without thought of the occurrence of other deposits than placer gold. However, the land department, and later, Congress, applied the law to oil lands. The placer law provides, in the main, that no location shall be made without a discovery of valuable minerals on the claim, that the boundaries of the location shall be plainly marked on the ground, that no claim for an individual shall exceed 20 acres or for an association 160 acres, that $100 worth of assessment work must be done each year, and that upon the expenditure of $500 in labor or improvements and upon compliance with certain minor requirements the claimant is entitled to a patent to his claim.

The claimant who has gone upon lands for the purpose of making mineral location, and is engaged in work looking to the discovery of minerals, is protected against adverse agricultural claimants on the ground that the land which he occupies is not vacant and open to settlement. The extent of his protection against adverse mineral claimants is, however, a matter of serious doubt. He can not be ousted by the forcible or fraudulent entry of another mineral claimant, but if such adverse claimant enters peaceably, openly, and in good faith, prospects the claim and first discovers minerals, thus perfecting his location, his title is superior and he dispossesses the original occupant. On the other hand, in some of the fields large areas are held indefinitely by assessment work which makes little pretense of exploring the claims or developing them. Useless roads which make the claims no easier of access, drilling rigs incapable of reaching the oil sands, building-stone locations where no building stone is to be found, and locations on worthless deposits of gypsum are among the subterfuges adopted to hold possession of lands prospectively valuable for oil. Thus, where occupancy without discovery is respected, large areas are withheld from exploration and development, and where such occupancy is not

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respected, the oil prospector must assume undue risk of the loss of his investment prior to discovery.

An objection of equal force to the placer law as applied to petroleum arises from the fact that the mineral is fluid. It moves underground. A well on one tract is likely to draw from a neighboring tract. Thus it becomes necessary for each operator to drill wells along his boundary lines before his neighbors do so. Otherwise they will draw off a part of his oil. He is therefore forced to drill whether it is otherwise to his advantage or not, in order to protect his oil deposits from exhaustion through adjacent wells.

We should, I believe, stimulate the search for oil and protect the prospector. The Government is withholding from entry certain considerable bodies of land in the belief that they contain oil, when this has not been demonstrated. It is our practice as soon as there has been a producing well discovered, and sometimes earlier, to withdraw all lands in the neighborhood which, in the opinion of experts, are of similar geological formation. The lands on which the discovery has been made or upon which exploration has been begun may or may not be included in the withdrawal. If they are, the law offers to protect the rights so acquired. I feel, however, that we are not sufficiently rewarding the pioneer. A plan could readily be evolved by which anyone wishing to prospect for oil on the public lands could obtain a license from the Government to exclusively prospect a large tract of land for a period of time—perhaps two years—and in the event that oil is found in commercial quantities the Government should be paid a royalty fixed in advance. This method is similar to that by which the Indian lands in Oklahoma have been developed and which has proved of the highest value in bringing capital into this work and insuring large returns to the Indians. In the Oklahoma case one great corporation, however, was given so large a body of land that after the original discovery it found it profitable to farm out its rights to subsidiary companies. This might easly be prevented by regulations under which the Government would reserve to itself the adjoining lands. Indeed, I would not be adverse to granting such a license in unexplored country for, say, four sections of land, and in the event of discovery permitting patent to issue to the discoverer for a full section, the balance of the licensed land to remain in the Government to be leased in small parcels to other parties on a royalty basis under the more advantageous terms that could then be secured.

The United States will need oil for its navy as well as coal, and probably in increasing quantities as the modern oil-burning or gas-burning engines are recognized. It would be economical to substitute oil for coal for many reasons; to reduce labor cost, to avoid the building and maintenance of colliers, and the purchase and support of coaling stations. The Diesel engine can, with the fuel carried from the home port, take one of our greatest ships around the world without dependence upon a renewal supply of fuel. England's adventure in this direction will presumably force other nations into like enterprise, and yet England has no oil fields on which to draw, while we have already the largest producing fuel oil fields in the world, and others are appearing. Already we know of oil in Alaska, and within a few weeks a fine grade of oil has been found on the Quinaielt Indian Reservation in Washington. The Indian oil lands we do not own. They belong to the Indians, and their product must be sold for the In-

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dians' profit. The one sole reservation of oil lands for governmental use is that in California, over the withdrawal of which litigation is now pending. Under these conditions it would seem of the highest expediency that the Government make such offers as will induce the proving of our lands, and of these proved lands retain sufficient to make our ships independent of the world and as fully competent as their rivals.

Further light is thrown upon the attitude of those at Washington who have been brought most intimately into contact with the problems of the oil lands by the following statement prepared by request by W. C. Mendenhall, chief of the Land Classification Board of the United States Geological Survey. As both Mr. Lane and Mr. Mendenhall are Californians the oil men are certain of a sympathetic hearing however much apart they and the administration may at first seem to be. Mr. Mendenhall's statement follows:

On various occasions and through various media, the Director, Mr. George Otis Smith, and his associates on the Survey staff have expressed the opinion that the best solution for the present unsatisfactory situation as to our public oil lands is to be found in a leasing law. Opinion among oil men, while of course divided on this matter, is distinctly more favorable toward the recognition of the leasing principle in federal law than when discussion of the subject began seriously a few years since. As a result of this increasing familiarity with the idea of federal leaseholds, interest has been transferred in part to the character of the law which might be enacted and to the details of the provisions which it should contain. The reports of committees appointed by various organizations, and the discussions contributed by individuals testify to this interest. To this phase of the discussion also members of the Survey have contributed from time to time by suggesting provisions which, as a result of their experience among oil men and with oil-land administration, seem to them desirable.

Among the general features of this type the following group, although of varying importance, and although there will doubtless not be agreement as to the desirability of their enactment into law, stand out as seriously worthy of discussion and of Congressional consideration:

1. A leasing law should distinguish clearly between the exploratory period and the productive period by providing for a preliminary prospecting permit to be followed by a lease.

The period of exploration leading up to discovery may in the case of oil lands be so extended, and such heavy expenditures may be required within it that the applicant during this interval should be definitely protected from interference by adverse claimants. He is not so protected under the present statutes. Indeed, as is well understood, he does not appear in the federal records under laws now in force until discovery is made and application for patent filed. Moreover, the exploratory period differs so essentially from the productive period following discovery that a lease whose terms are appropriate to the earlier period will usually not be appropriate to the later. For these reasons, therefore, it seems very desirable that these two distinct steps in the production of oil should be recognized in any new law and particularly that full protection should be accorded the applicant for lands while he is taking the first of these steps.

2. The law should discourage idle holdings and speculation. It should be made easy for the applicant who in-

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tends to engage in *bona fide* development to secure the necessary rights, but it should be made as difficult as possible for an applicant who does not develop, to tie up lands and idly await an increase in value due to neighboring developments.

Although these ends probably can not be attained, aids to their attainment will be secured by limiting the life of the prospecting permit to a period sufficient to accomplish discovery under the most adverse conditions, say two or three years, and by imposing a rental charge upon leases, this rental charge to become a credit on the royalty so that it will be actually exacted only in case there is no production. It appears scarcely necessary to advance arguments in support of a clause in any new law which will limit the acquisition of lands under it to those who will use the lands for the purpose for which they are acquired. The plan most frequently suggested for the accomplishment of this end is that outlined above.

3. A sufficiently large acreage should be provided to serve as a basis for a healthy and profitable industry, but not enough to enable a single individual or company to control a field of ordinary extent and thereby to destroy healthy competition.

No flat statement can be made as to the acreage that can properly be included in a single permit or lease, because fields differ so widely in quantity, quality, and cost of product that an area that is appropriate in one field is inappropriate in another. In the proved portion of the highly productive California fields 80 or 160 acres will amply reward the enterprise and industry of their lessee. In other fields, like some of those of the Rocky Mountain area, 640 or 1280 acres is not too great an amount for inclusion in a single lease in order that a successful industry may be established. Probably the best way to provide for such diversified conditions is to specify in the law a maximum acreage that may be included in a single leasehold, leaving to the discretion of the Departmental officers, guided by experience in the individual fields, the determination of areas below this maximum.

4. The financially hazardous character of oil exploration in untried fields should be recognized and special encouragement should be given to exploration of this type.

The so-called 'wild-catter' is the pioneer of the oil industry. He should be accorded the encouragement and the special rewards which are the pioneer's due, in so far as it is practicable to provide by statute for such a reward. The first difficulty that arises in endeavoring to frame such a provision is to define 'wild-catter' or 'unproved territory.' Perhaps the desired end can be attained by providing that discovery at some arbitrary distance, say 3, 5, or 10 miles, from any producing well shall entitle the discoverer to remission of all rental and royalty or to a double leasehold. This latter plan is less favorably regarded than the former because of the difficulty of administering it. The former plan seems, however, to provide rather meagre reward for the special hazards encountered by the pioneer.

5. A maximum royalty should be provided of some fixed proportion, say one-eighth of the gross output, to be paid in cash or in product at the option of the Government.

It is recognized that the Government should not enter into the leasing business primarily for the purposes of revenue, but chiefly in order to exercise such control as may be exercised in the interests of consumers of the product, coupled, as this end must be of course, with due protection to the pro-

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ducer. The Government should be reimbursed for the costs of administration and its receipts should be sufficiently high to enable it to pay to the states an amount that will at least fully compensate them for their inability to tax the leased lands. To cover this latter point some definite percentage of rentals from the leaseholds should be turned into the state treasury. The Secretary of the Interior should have the authority to fix royalties at any point below the maximum where the conditions of the industry indicate that they should be fixed. For example, in order to encourage production from a developed field when that field is approaching exhaustion it may be highly desirable that all charges be reduced to the minimum. Otherwise, the field will be abandoned earlier than would be necessary and the petroleum products remaining in it unextracted will be wasted and mankind deprived of their use. In view of the increased importance of oil as a fuel for naval purposes and of the struggle among the nations of the world to acquire valuable oil lands suitable for naval reserves, the Government certainly should have the option of collecting its royalties in oil, when conditions demand it.

6. Provision should be made for the separation of the mineral and agricultural estates so that where practicable and desirable agricultural and mineral development may proceed together.

Some of the oil fields are in regions where the lands are valuable agriculturally and in some of the poorer fields oil development will not preclude agricultural development. Furthermore, all prospective oil lands should be held for disposition under any law that may be enacted, but agricultural development meanwhile should not be interfered with. It appears to me that, for these reasons, any proposed law should provide for a separation of the agricultural and mineral estates and their independent disposition. Such a provision now exists as to one state—Utah (37 Stat., 496).

7. There should be ample provision for the readjustment of the terms and conditions of the lease at moderate intervals.

A lease should run through the period of production of the lands involved, because once wells are drilled and the market and the business established, those who are on the ground can extract all of the available product of the field to better advantage than could subsequent lessees who might enter the field after a portion of its oil had been withdrawn. The period of production is usually of moderate duration and rarely extends beyond one generation. Pehaps then a lease may well be made indeterminate as to period, but, because of the rapidly changing character of the oil business and of the fact that conditions can not be foreseen for any great distance into the future, definite provision should be made for the readjustment of the terms of the lease at short intervals—say 10 years.

8. The simplest and most direct administration possible should be provided for by giving ample powers to the administrative officers. Red tape and expense in administration are fostered by laws which attempt to prescribe the details of procedure. I should therefore consider it desirable that in any law the Secretary should be given definite power to draft rules and regulations for the administration of the act and to prescribe the details by which the principles which the law may establish shall be made effective.

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Sewage at Stockton, California

By E. L. GRUNSKY*

THE city of Stockton, California, (population 25,000; including outside suburban areas about 32,000) is situated at the head of Stockton channel, which at one time was the drainage outlet for a considerable area of the San Joaquin valley and outlying hills of the Sierra Nevada mountains. The surface run-off which originally reached this water-way was cut off in 1910 by a diverting canal. One of the arms of Stockton channel is known as Mormon slough. Both Mormon slough and Stockton channel are navigable waters.

A sewer system, for sewage only, was constructed for Stockton about 25 years ago. This has rendered satisfactory service, until quite recently, as a collector of sewage. Now mains of larger capacity are required and a sanitary method of disposal is to be adopted. The sewage was led to a pumping station on the bank of Mormon slough within the city limits and pumped from that point to the San Joaquin river, a distance somewhat in excess of 2 miles.

After a number of years the outfall pipe gave more or less trouble and a discharge through the same was discontinued, sewage thereafter being pumped for a time upon overflowed land lying between Stockton and the San Joaquin river, and still later directly into Mormon slough. Until the diverting canal was constructed in 1910, there was some flow in Mormon slough during the winter and spring months. Since the construction of the diverting canal the sewage delivered into the dead water of the slough has made it very foul and the nuisance created thereby has gradually become unbearable.

Both Stockton channel and Mormon slough are subject to tidal action. At the low stage of the river, generally from August to December, there is a tidal range at Stockton of about 2 feet. The sewage in Mormon slough is pushed back and forth by the tide over a stretch of a few thousand feet without any chance of escape and has converted this part of the slough into an open septic tank. The slough is black with filth, its bed is covered with a thick deposit of fermenting sludge, and so long as the delivery of sewage at that point continues the conditions will steadily grow worse.

The city is about to remedy this situation by the construction of modern disposal works and will at the same time extend its sewer system to serve outlying parts of the city and the rapidly growing suburban areas. As a preliminary to the design of the proposed improvements a study was made of the amount of sewage to be delivered, of its character, and of the trade wastes which must be given consideration in planning disposal works. Some notes relating to the trade wastes will be submitted in a later article.

Quantity of Sewage:—At the pumping station there are two 10-in. centrifugal pumps. The sewage flows into

*With the American Engineering Corporation, San Francisco, Cal.

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a circular sump 36 ft. diameter. It is discharged through a 14-in. pipe about 500 ft. long into Mormon slough. It was found impracticable to determine the rate of flow by direct measurement in the sump owing to small capacity below the sewer invert. It was therefore decided to estimate the rate of flow by rating one of the pumps and determining the rate of flow from hour to hour from the number of pump revolutions. The observations on the rating of the pump was somewhat complicated. It was necessary to determine the discharge for various positions of the gate valve on the discharge pipe as well as for various speeds of the pump. The result of the pump rating is shown in Fig. 1.

The sewage before entering the circular sump passes through a grating constructed of iron bars about 1½ in. apart. The grating is not an effective interceptor of rags and like material

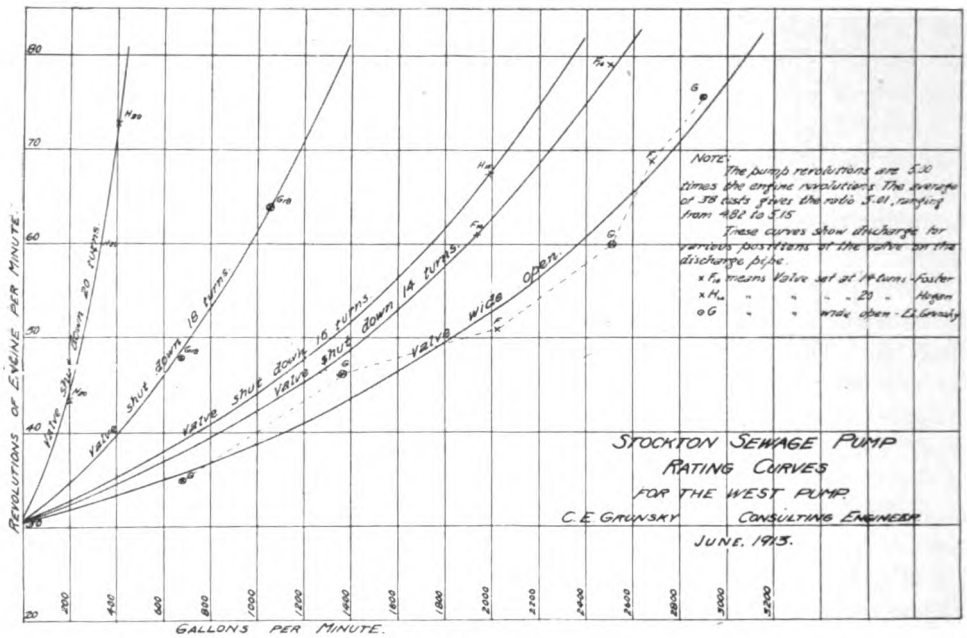

FIG. 1.

which the determination of sewage discharge is based were made during the same period of time—March 10 to March 14, 1913—during which samples were taken for chemical analyses and other tests.

The sampling of the sewage required that the discharge be throttled at certain hours of the day when the sewage flow was light. Throttling was necessary at times, too, in order to keep the water surface in the sump at a uniform level. In consequence of this throttling and it was found during the tests that occasionally rags would be caught by and wound around the pump shaft. To some extent there must have been some interference with free flow by such an accumulation of rags during the tests, but this was not considered a matter of material importance, because the observations were continued over a long enough time to give reliable results even though possibly somewhat in error at certain hours of the days covered by the records. If there is any apprecia-

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ble error due to this cause, it is in the direction of an over-estimate of sewage flow and has been regarded as an additional safety margin.

The pumps are belt driven from steam engines. The impeller of the pump makes 5 revolutions for each revolution of the engine. The west pump alone was used throughout the tests. It was found that 31 engine revolutions were necessary to effect any discharge no matter what the position of the valve on the discharge pipe. It was also found that at 21 turns from a marked position the gate-valve would shut off all discharge. A variation of a few feet in the elevation of the water surface in the sump had very little effect upon the discharge. Throughout the period of observation, however, sewage in the sump was kept as near as practicable within ½ ft. of an adopted elevation.

In determining the rate of flow at different hours of the day during the period covered by the observations, short periods, generally of one to two hours' duration, were selected at the beginning and the end of which the water surface elevation in the sump was exactly the same. The final results are shown in the following table, and also in Fig. 2.

Chemical Analyses:—The samples for screening tests, for sedimentation tests and for the chemical analyses were taken from the discharge pipe through a 1-in. pipe and a hose leading off therefrom just above the gate valve. When necessary to produce a free flow through the hose the gate valve on the discharge pipe was turned down as far as necessary.

Samples representing a 24-hour flow were taken on four days, and additional samples were taken for four periods of 6 hours each. All of the samples taken were composite samples. Each sample was one gallon in amount, or about 3600 cubic centimetres. A preliminary approximation of the hourly variation of sewage flow was made the basis of estimating the quantity of sewage to be taken at various hours of the day. The sample as taken and the sample that would strictly conform to the

TABLE I

SEWAGE DISCHARGE AT STOCKTON. ESTIMATED AT THE PUMPING STATION, MARCH 10 TO 14, 1913.

Hour.	March 10.	March 11.	March 12.	March 13.	March 14.	Average.
12 midnight	1800	1570	1300	....	1520	1550
1 a. m.	1700	1370	800	....	1260	1280
2 a. m.	1600	1330	700	....	1100	1180
3 a. m.	1550	1310	710	....	900	1140
4 a. m.	1520	1260	930	....	....	1240
5 a. m.	1550	1070	1250	....	....	1290
6 a. m.	1600	1130	1700	....	....	1480
7 a. m.	1750	1300	2050	....	....	1700
8 a. m.	1950	1470	2200	1500	....	1780
9 a. m.	2200	1650	2230	2320	....	2100
10 a. m.	2380	1850	2260	2350	....	2210
11 a. m.	2400	2250	2300	2300	....	2310
12 noon	2400	2300	2320	2260	....	2320
1 p. m.	2330	2300	2320	2220	....	2290
2 p. m.	2250	2300	2320	2180	....	2260
3 p. m.	2270	2290	2330	2150	....	2260
4 p. m.	2300	2250	2330	2120	....	2250
5 p. m.	2300	2200	2350	2100	....	2240
6 p. m.	2300	2150	2350	2050	....	2210
7 p. m.	2280	2080	2310	1970	....	2160
8 p. m.	2100	2010	2280	1870	....	2065
9 p. m.	1780	1910	2270	1820	....	1945
10 p. m.	1780	1800	2220	1820	....	1905
11 p. m.	1760	1600	....	1770	....	1710

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TABLE II

COMPOSITE SEWAGE SAMPLE

Time of sampling.	Time represented by partial sample. Hours.	Estimated partial sample. C. C.	Partial sample as taken. C. C.
1:30 a. m.	3	306	366
4:30 a. m.	3	309	350
7:00 a. m.	2	267	280
8:30 a. m.	1	156	149
9:30 a. m.	1	173	159
10:30 a. m.	1	181	168
11:30 a. m.	1	186	176
12:30 p. m.	1	190	174
1:30 p. m.	1	186	181
2:30 p. m.	1	181	179
3:30 p. m.	1	180	174
4:30 p. m.	1	180	171
5:30 p. m.	1	178	168
7:00 p. m.	2	344	318
9:00 p. m.	2	315	296
11:00 p. m.	2	257	270
Total	24	3589	3580

average flow are shown in Table II.

The samples were all taken and cared for with the usual precaution to prevent chemical changes before reaching the laboratory. The sanitary analyses were, through the courtesy of the State Board of Health, made by the chemist of the Board, M. E. Jaffa of the University of California. All partial samples received a small addition of chloroform and were kept on ice until the composite was complete.

The results of the analyses are presented in Table III and Table IV as follows:

Sedimentation Tests:—Imhoff test tubes were used in making the sedimentation tests. Eleven samples were taken in each of two 24-hour periods of which the first began on March 11 at 7 a. m. and the second on March 12 at 7 a. m. The results of the sedimentation tests are presented in Table V and Table VI, and also in Fig. 3.

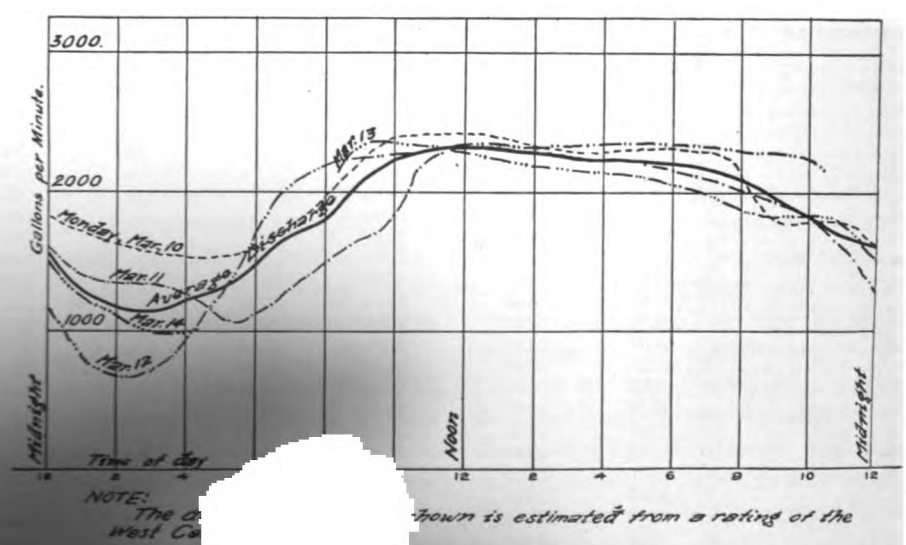

FIG. 2.

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TABLE III

SANITARY ANALYSES OF SAMPLES OF SEWAGE

Stockton, California

24-Hour Composites. Designation.	Parts per million. Monday Mar. 10.	Tuesday Mar. 11.	Wednesday Mar. 12.	Thursday Mar. 13	Average.
Total solids—Total	1132	1055	1123	1020	1083
Loss on ignition—Organic	443	391	424	351	402
Non-volatile—Mineral	689	664	699	669	680
Suspended solids—Total	233	163	178	168	185
Loss on ignition—Organic	200	104	94	96	123
Non-volatile—Mineral	33	59	84	72	62
Dissolved solids—Total	899	892	945	852	897
Loss on ignition—Organic	243	287	330	255	278
Non-volatile—Mineral	656	605	615	597	618
Nitrogen—Total by Kjeldahl	34	32	32	34	33
Nitrogen—Organic by Kjeldahl	13	15	11	13	13
Nitrogen—Free ammonia	19	16	19	20	18
Nitrogen—Albuminoid ammonia	8	7.2	6	7.2	7.1
Nitrogen—Nitrites	0.024	0.095	0.095	0.06	0.068
Nitrogen—Nitrates	0.50	0.75	0.50	0.50	0.56
Oxygen consumed 10 minutes	213	200	182	164	189
Oxygen consumed 5 minutes	184	180	138	133	158
Chlorine	269	241	280	237	256
Fats	58	60	61	75	63
Alkalinity as $CaCO_3$	..	....	....	287	287

TABLE IV

SANITARY ANALYSES OF SAMPLES OF SEWAGE

Stockton, California

6-Hour Composites Designation.	Parts per million. Monday, Mar. 10, 6 a.m. to 12 noon.	Wednesday, Mar. 12, 12 mid. to 6 a.m.	Wednesday, Mar. 12, 12 noon to 6 p.m.	Thursday, Mar. 13, 6 p.m. to 12 midnight.
Total solids—Total	1216	840	1092	921
Loss on ignition—Organic	380	291	466	374
Non-volatile—Mineral	836	549	626	547
Suspended solids—Total	179	110	212	162
Loss on ignition—Organic	173	98	153	135
Non-volatile—Mineral	6	12	59	27
Dissolved solids—Total	1037	730	880	759
Loss on ignition—Organic	207	193	313	239
Non-volatile—Mineral	830	537	567	520
Nitrogen—Total by Kjeldahl	39	21	35	31
Nitrogen—Organic by Kjeldahl	14	9	14	12
Nitrogen—Free ammonia	24	12	23	18
Nitrogen—Albuminoid ammonia	9	4	7.2	5.2
Nitrogen—Nitrites	0.06	0.015	0.08	0.01
Nitrogen—Nitrates	0.90	0.25	0.40	0.40
Oxygen consumed 10 minutes	387	107	180	165
Oxygen consumed 5 minutes	352	71	136	137
Chlorine	375	205	198	177
Fats	42	62	83	60
Alkalinity as $CaCO_3$	....	...	....	281

Screening Tests:—The apparatus used in making screening tests was patterned after a very simple appliance which had recently been successfully used at Sacramento under the direction of Chas. Gilman Hyde.

A sieve about 3 by 4 in. covered an opening of the same size cut into a semi-cylindrical recipient, Fig. 4, which was so suspended beneath a constant flow orifice that it could be quickly swung under and as quickly removed from under the orifice. To secure a constant flow orifice an ordinary 5-gallon oil can was used, Fig. 5. One of its sides at the top was bent over to form a discharge spout and thereby to keep a constant head on the orifice. In

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TABLE V

IMHOFF TUBE SEDIMENTATION TESTS

Sewage at Pumping Station, Stockton, California, March 11-12, 1913

Sediment (by volume) parts per million.

Time of sampling.	5 min.	15 min.	30 min.	45 min.	60 min.	90 min.	120 min.	180 min.
March 11, 1913:								
7:08 a.m.....	100	200	200	200	200	200	200	200
9:00 a.m.....	2000	4000	4300	4500	5000	5000	5200	5200
11:00 a.m.....	2000	2500	3000	3000	3500	3500	3500	3500
1:00 p.m.....	1000	2000	2500	2500	2500	3500	3500	3000
3:00 p.m.....	1000	3500	3000	3000	3300	2800	3000	3000
5:00 p.m.....	1500	3000	3300	3700	3900	4000	4200	4500
7:00 p.m.....	700	1500	2000	2200	2300	2400	2500	2800
9:00 p.m.....	800	1100	1800	1700	1800	1800	1900	1900
11:00 p.m.....	500	2000	2500	2800	2800	2800	2800	2900
March 12, 1913:								
1:30 a.m.....	Trace	1200	2200	2500	2900	3000	3200	3400
4:30 a.m.....	Trace	200	500	600	700	700	800	1000
Average	800	1770	2110	2270	2410	2480	2550	2620

TABLE VI

IMHOFF TUBE SEDIMENTATION TESTS

Sewage at Pumping Station, Stockton, California, March 12-13, 1913.

Time of sampling.	5 min.	15 min.	30 min.	45 min.	60 min.	90 min.	120 min.	180 min.
March 12, 1913:								
7:00 a.m.....	1000	2500	2500	2000	2000	2000	2500	2500
9:00 a.m.....	1000	2000	2500	3200	3500	3500	3500	3500
11:00 a.m.....	1000	2000	4000	4000	4500	4000	4500	4500
1:00 p.m.....	1000	1000	1500	1500	1600	1600	3000	3000
3:00 p.m.....	500	1500	1500	1700	1500	3000	3000	3000
4:10 p.m.....	500	1500	3200	....	....	....	....	....
5:00 p.m.....	1000	1500	1700	1700	2500	2700	3000	3100
7:00 p.m.....	200	1000	1600	2000	2300	2400	2500	2600
9:00 p.m.....	200	600	1200	1300	1400	1700	1900	2000
11:00 p.m.....	200	400	600	1000	1400	1600	1600	1800
March 13, 1913:								
1:30 a.m.....	600	1200	1600	1700	1700	1700	2000	2300
4:30 a.m.....	Trace	300	300	300	300	400	500	600
Average	600	1280	1850	1980	2180	2340	2630	2660

its bottom near one side a clean round hole was cut that was about ⅝-in. diameter.

The flow through this orifice was carefully gauged by catching and weighing the same for a number of periods of 60 seconds each. The screening was continued throughout two periods of 24 hours each, of which the first commenced at 6 a. m. on March 11 and the second at 6 a. m. on March 12. At each hour set for a screening test a proportional part of a total 24-hour quantity of one million cubic centimetres was passed through the screens. The schedule is given in Table VII.

The results of the screening tests with the 40-mesh and the 50-mesh screens are condensed in Table VIII and Table IX.

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TABLE VII

SCREENING SCHEDULE

Sewage at the Pumping Station, Stockton, California.

Time.	Number of seconds.	Amount screened c.c.	Amount screened in 6-hour periods, c.c.
6:30 a.m...	142	37,200	.....
7:30 a.m...	158	41,400	.....
8:30 a.m...	159	41,700	.....
9:30 a.m...	169	44,300	.....
10:30 a.m...	179	46,900	.....
11:30 a.m...	187	49,100	260,600
12:30 p.m...	186	48,700	.....
1:30 p.m...	192	50,300	.....
2:30 p.m...	191	50,100	.....
3:30 p.m...	185	48,500	.....
4:30 p.m...	183	48,000	.....
5:30 p.m...	178	46,700	292,300
7:00 p.m...	339	89,000	.....
9:00 p.m...	316	82,800	.....
11:00 p.m...	288	75,500	247,300
1:30 a.m...	389	102,000	.....
4:30 a.m...	373	97,800	199,800
	3814	1,000,000	1,000,000

When compared with the total amount of suspended matter in the sewage, as shown in Table VII, it will be seen that about 9% of the suspended

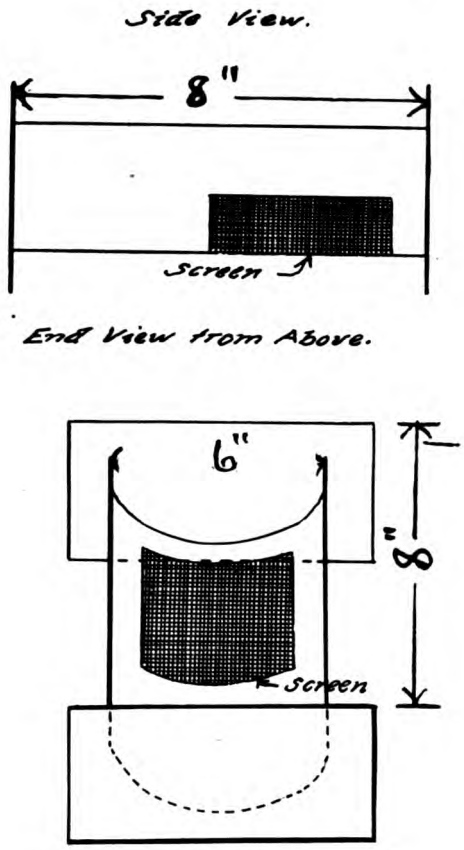

FIG. 4.

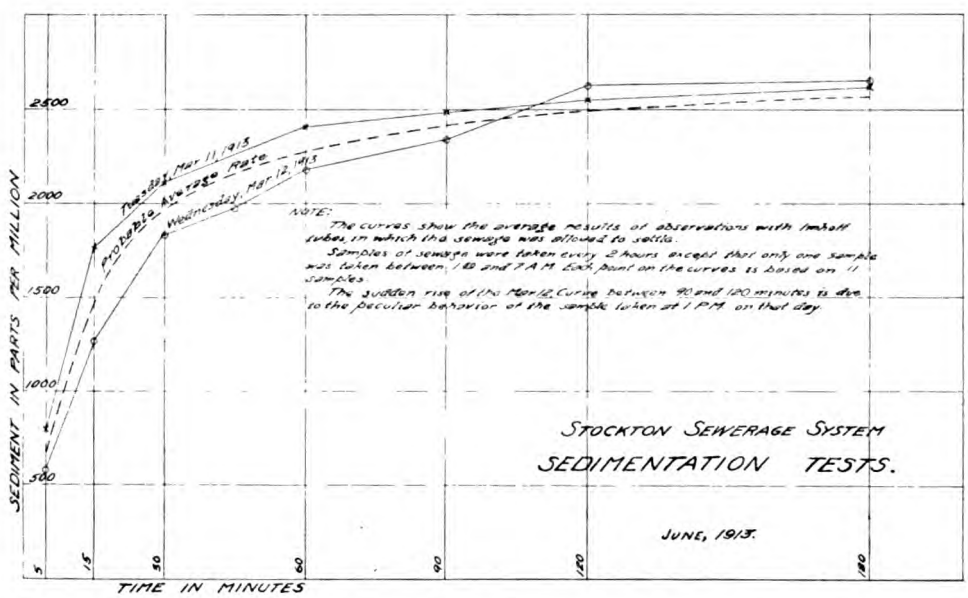

FIG. 3.

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matter could be removed from the sewage (after it has passed through the pump) with a screen having 40 meshes to the linear inch and about 10% with a screen having 50 meshes to the inch.

FIG. 5.

The foregoing studies were in charge of the writer under the direction of C. E. Grunsky, Consulting Engineer, who is advising Stockton in the matter of its proposed improved sewer system.

[Rapid growth of population in small cities has brought out many interesting problems in municipal engineering, not the least of which is that of sewage disposal. The foregoing studies by Mr. Grunsky in behalf of the city of Stockton are of especial interest as an indication of the growing tendency to investigate scientifically rather than to adhere to the rule of thumb methods formerly in vogue.—EDITOR.]

TABLE VIII

SCREENING TESTS

Sewage at the Pumping Station, Stockton, California.

Amounts retained on a 40-mesh screen.

Date and period.	Amount screened. Gal.	c.c.	Wt. of screenings. Wet, gm.	Dry, gm.	Vol. of screenings. Wet, c.c.	Dry, c.c.
March 11, 1913:						
6 to 12 a.m.	68.72	260,600	17.56	2.59	18	9
12 to 6 p.m.	77.20	292,300	23.20	5.05	25	15
6 to 12 p.m.	65.22	247,300	18.76	3.85	19	11
12 to 6 a.m.	52.80	199,800	7.90	1.60	9	5
March 12, 1913:						
6 to 12 a.m.	68.75	260,600	21.95	4.60	22	13
12 to 6 p.m.	77.20	292,300	36.85	8.61	41	27
6 to 12 p.m.	65.22	247,300	17.06	2.95	18	10
12 to 6 a.m.	52.80	199,800	7.20	1.31	7	5

TABLE IX

SCREENING TESTS

Stockton Sewage.

Date and period.	Amount screened. Gal.	c.c.	Wt. of screenings. Wet, gm.	Dry, gm.	Vol. of screenings. Wet, c.c.	Dry, c.c.
March 11, 1913:						
6 to 12 a.m.	68.75	260,600	27.77	4.57	25	15
12 to 6 p.m.	77.20	292,300	27.35	5.80	27	18
6 to 12 p.m.	65.22	247,300	24.60	5.25	25	16
12 to 6 a.m.	52.80	199,800	7.38	1.22	8	4
March 12, 1913:						
6 to 12 a.m.	68.75	260,600	24.87	5.35	25	16
12 to 6 p.m.	77.20	292,300	27.82	6.55	27	20
6 to 12 p.m.	65.22	247,300	16.91	3.70	17	12
12 to 6 a.m.	52.80	199,800	7.03	1.18	7	4

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Aerial Acrobatics*

[During the past few weeks the aviator, Beachy, has excited much interest by his loops, his S flights, and his acrobatics generally. To those who observe with their brains, as well as with their eyes, his work has been more than mere lofty tumbling. It has indicated a control of the aeroplane exceeding in accuracy anything heretofore exhibited in this part of the world. His work in the main is the logical sequence of that of Pégoud of France, the pioneer in such feats, following whose work a lively discussion started in France, a part of which is here given.—TRANSLATOR.]

SINCE Pégoud's original upside-down flights at Buc, he has repeated his flights in other places in Europe; other aviators also have imitated him successfully, both with biplane and with monoplane; many persons considered these flights as acrobatics, wholly useless for scientific and practical results. Among varying opinions, we must cite first that of those persons who say that if Pégoud has demonstrated that the aeroplane can fly in diverse positions, and consequently has the ability to recover its normal position when suddenly capsized or placed in jeopardy, this is a very queer method by which to search for the stability of the aeroplane. One such critic wrote in *La Nature* as follows:

"All of the serious efforts of Etevé, Doutre, Moreau, and others, are directed to the end that the aeroplane shall be so constructed that it never can be placed in jeopardy. This will be accomplished by the inclination angle given to the stabilizing planes, and it is well to know that this experiment just made voluntarily by Pégoud has been made involuntarily by other aviators. If the aeroplane is such that the aviator can jeopardize it voluntarily, is it not to be feared that, unless he is a 'virtuoso,' he involuntarily will jeopardize it? Then, at the risk of what constant danger will he gain this possibility of security under exceptional conditions?

"And that is not all. An aeroplane while inverted is defenselessly exposed to all hazards of the atmosphere. When inverted it flies under conditions quite the opposite from those for which it was constructed (at least it is to be hoped this is so for the good fame of the designer), conditions of equilibrium exceedingly uncertain. Later it must return to its normal position; and incur a second risk. Who, except a virtuoso of the air, would incur that double chance? With equal force it might be asked, how many passengers would sail in a vessel, that, as a preventive against the dangers of a high sea, will have the ability to navigate keel upward?

"The inevitable conclusion then is: Pégoud showed that the exceptional aviator, in a hopeless position, has as a last chance a life preserver which no experiment previously has indicated.

"Will this result advance the art? In no way. Will it hinder it? Possibly, because it threatens to direct investigation along improper lines and creates a new premium on virtuosity, which (do aeroplane builders understand this only imperfectly?) is the first barrier against the vulgarizing of aviation."

To those arguments must be opposed the following opinions, which are taken

*Translated from the Esperanto in *Scienca Gazeto*, December 1913, by A. H. Babcock.

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also from *La Nature*. The author, Dr. Emile Raymond, in reply to the foregoing opinion, expressed himself as follows:

"I am of the opinion that this criticism is severe, and, although the progress of aviation very greatly hinders the freedom with which one may dare speak on such matters, I think I may say that the experiments of Pégoud have a value and will have a result inevitably practical, and that possibly a number of aviators in future may owe their lives to him. The criticisms of Pégoud come nearly all from those who, considering the present state of aviation, its security and the stability of its apparatus, cannot appreciate the value of investigations which aim to return to safety an aeroplane that is accidentally thrown in an abnormal position.

"Well, the question in no way is such; the experiments of Pégoud in no way hinder the partisans of automatic stability from continuing their efforts. What we do know is that up to today they have not accomplished the task to which they set themselves. Many different causes, beyond the will of the aviator, can place an aeroplane in a dangerous position; for example, it may fall more or less vertically under conditions whereby the air forces instead of acting on the lower surface of the planes, strike the upper, so that the wings become supporting surfaces, no longer by their concave but by their convex sides.

"In what situation is the aviator thrust when his apparatus thus is in jeopardy? Certain theorists clearly and scientifically reply that an aeroplane so situated never can be restored to normal position, and this conviction, accepted by aviators of certain training, will take from them at the critical moment the means whereby they would be able to save their lives.

"What Pégoud has demonstrated is that, in whatever manner the aeroplane may be jeopardized, control can be recovered by the aviator, and that whatever position it has in the air, and gusts or faulty maneuvring can give it, the normal position always can be regained.

"It is therefore merely sufficient for every aviator, whose apparatus tumbles or turns over, not to lose his head, but to know that restability depends on him.

"Is it necessary to push these daring experiments further beyond present knowledge, as did Pégoud, and to give to an aeroplane all possible positions, even those it only very improbably could assume, even in a gale? Originally that might have appeared useless; but the results proved the contrary. It has been proved that an aeroplane, while describing an S flight, reaches its inverted position by falling forward vertically head first, later with wheels upward, that is, by a modification of its longitudinal equilibrium by means of the elevator, and that it regains its normal position by a similar action.

"Pégoud uses less time for reversal of his apparatus than for the return to normal; he loses 50 metres of altitude placing his apparatus in the inverted position with wheels up, and 150 metres to re-establish normal conditions, when that movement takes place in a vertical plane.

"Stated briefly, the longitudinal stability is greater for an aeroplane in the inverted position than in the normal.

"If, on the contrary, Pégoud endeavored to invert his aeroplane by rotation about the side extremity of the wing, that is, laterally, transversely, he could pass from the normal to the inverted position only with extreme

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difficulty,† but very easily he could recover his normal position from the inverted. This signifies that the transverse stability is greater in the normal position of the aeroplane than when inverted.

"And what practical conclusion may the practical aviator draw if it should happen to him, as to others, that he suddenly finds himself head downward? What shall he do? He can recover in a vertical plane by his elevators; but easier by turning transversely about the outside edge of the wings, by means of the ailerons or warping planes, and the rudder.

"In conclusion, when he is head downward, he will not operate the elevators, but will turn right or left (by the warping planes), and will operate the rudder on the same side. This is practical and very valuable advice. The experiments of Pégoud should not be regarded as useless *tours de force*; on the contrary, they are the happy efforts of an audacious naturally wise man."

Some possibly will continue to regard these inverted flights, loops, etc., made by those men as only acrobatics, but these audacious flights have demonstrated a stability of the aeroplane unknown until then, and even by this alone have proved their useful value, because their results can open new fields of research not foreseen, which later will be useful to increase the security of flights by aeroplane.

University of California Extension Division

ANNOUNCEMENT has been made by the extension division of the University of California of the formation of a bureau of municipal reference for the use of any citizen of the state, and especially for officials of California municipalities. A municipal reference library is in process of collection, and data from the technical press and other sources are to be catalogued and indexed for further reference. The bureau will also secure correspondents in the principal American cities to assist in the collection of franchises, charters, and other documents, and will supply as far as possible information on all subjects of municipal organization, administration, water purification, food inspection, traffic regulation, dust prevention, public ownership, accounting methods, finance, education, and other matters of civic concern. As the resources of the bureau will be necessarily somewhat limited during the period of organization, only the more general subjects can be handled, for the present, but by gradual growth it will ultimately become an agency of great usefulness. Mr. Ira Woods Howerth is director of the University extension division and Mr. Joseph H. Quire is secretary of the bureau of municipal reference, and all correspondence should be addressed to him.

†This was demonstrated practically by Pégoud at Buc, France, Sept. 21, 1913, when he tried unsuccessfully four times to invert his aeroplane by this maneuvre. He was not able to turn completely over, "Because," he said, "the monoplane is too stable."—TRANSLATOR.

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Churn-Drilling to Determine Foundation Rock

By W. W. EDWARDS*

IN examining bedrock to determine the feasibility of possible dam sites, the Sierra & San Francisco Power Co. had recourse to the well known Keystone churn-drill. It was necessary to make explorations to determine the depth of bedrock directly under the river bed, where the great quantity of water prohibited the use of shafts. Two No. 3 Keystone drills were used on the work, one at each of the sites examined. The bedrock was covered with overburden to depths up to 60 ft. This overburden was varied in character. In some places fairly uniform gravel was encountered, but generally seams of gravel, patches of boulders, clayey streaks, and running sand were passed in each hole drilled.

Most of the holes were drilled in the bed of the stream. Extra heavy drive pipe 5⅝ in. inside diameter was used. The machine was set up on timbers. The drill was started and the spot noted for the pipe. The pipe, with a heavy drive shoe attached, was placed on the spot determined, and was held in place by bars or other means until it had penetrated far enough to stand alone. The pipe was driven ahead of the drilling whenever possible. By this means seepage water was kept out to a great extent, thus minimizing the danger of hydrostatic pressure forcing sand and gravel into the pipe. This also enabled the driller to get a more accurate record of strata penetrated. In drilling through sand, clay, or gravel which did not contain rocks larger than two or three times the size of a walnut, it was generally possible to drive from 6 to 15 in. at a time. The hole was pumped out, then drilled, then pumped out again, then driven again, and so continuing. Care was necessary when drilling in loose gravel that the bit did not reach too deeply below the drive shoe, as the pipe would often fill up when the arch of stones below the shoe was disturbed.

The main trouble encountered was from the boulders. A small boulder would stop the driving of the pipe. It was sometimes possible to drive it aside or break it by dropping small stones into the pipe and drilling on them, or, in other cases, by drilling alone. The pipe would then be driven past. There was always danger, however, that in driving past boulders the shoe would be broken or the pipe would be bent so much that the drill stem would chafe and bind. In a case like this it was sometimes possible to straighten the pipe by pulling it slightly and re-driving. In a few cases the pipe broke at a joint and that part below the break was lost. In other cases it was impossible to straighten the pipe, and the hole had to be abandoned, but this was not often necessary.

*Confidence, Tuolumne county, California.

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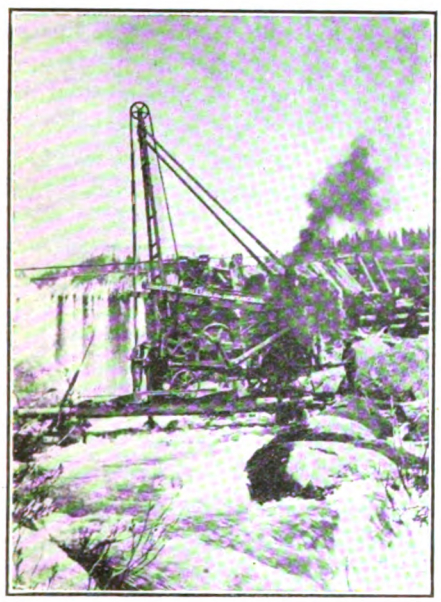
Large boulders necessitated other measures. If the strata below a large boulder did not cave into the hole the drive shoe was left resting on the top of the boulder and the hole continued below without pipe. But generally the material below caved into the pipe, and so when a boulder was encountered which stopped the driving of the pipe, drilling was continued till the boulder was passed through showing it was not



KEYSTONE DRILL AT WORK.

bedrock. The hole was then pumped out, or filled, to a point about half way through the boulder. A charge of dynamite was then prepared and lowered into place, extreme care being taken to insure that the charge reached to and rested upon the bottom. The size of the charge varied with the size of the boulder but was usually about 5 lb. of 40% dynamite. Either fuse or electric firing was used. Great care was necessary to insulate the charge properly against water. The end of the fuse or leadwire was passed out of the pipe through a hole bored in a short section of pipe attached above water level. The pipe was then pulled about 5 or 6 ft. so that the shoe would be a safe distance above the shot. The charge was then exploded, after which drilling was resumed. Generally the dynamite did the work well, and no further trouble was experienced from the boulder. Sometimes, however, it was necessary to repeat the blasting before the pipe could be driven past.

When rock was encountered it was, of course, unknown whether it was really bedrock or a boulder. If drilling 10 to 20 ft. into it disclosed no change it was considered to be bedrock, especially if the depth at which it had been struck agreed with that shown in other holes near by. The drive shoe resting upon bedrock or driven slightly into it cut off gravel and sand from caving into and filling the hole.

A close watch of the material brought up by the sand pump together with the conditions of driving the pipe showed the character of the strata pierced. If rounded grains or running sand was brought up by the pump, it was clear that the shoe was in sand or gravel. If in this case the pipe could not be driven, it was known that a boulder had caught the edge of the shoe. When bedrock or a large boulder was encountered it was evidenced by the inability to drive pipe, and the fact that the material pumped out was angular and the grains all of the same texture. Whether the rock was bedrock or a boulder was determined by the depth at which it was struck, its persistence in depth, and by comparison of the texture of the rock with previous samples of bedrock. When no difficulties were encountered, that is, when the material was homogeneous gravel, sand, clay, or bedrock, in fact anything not containing boulders, the rate of drilling was about 25 to 30 ft. per 10-hour

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day, but when boulders were met the daily progress would fall sometimes even to 3 or 4 ft. On an average it took about five days to drill a 40-ft. hole from set up to set up. Three men constituted the crew: driller, assistant, and fireman. Two men could do the work when conditions were good, but it was more economical to have three men, as the drilling was almost always in awkward places.

Oil was used as fuel on one drill. About 55 gallons per day was consumed. The other drill burned wood at the rate of about one cord per day. No trouble was experienced in keeping up steam with wood when the boiler was in good condition. It is true that under good conditions for drilling one cannot get with a churn-drill as perfect a sample of the underground strata as with a core-drill, but it is doubtful if a core-drill would give good results in such conditions as described above where so much water, running sand, and gravel were encountered. Again the ability to move the machine by its own power and the ease of setting up are factors that must be considered. Also the ease of getting repair parts is no small item in favor of a widely used machine. Subsequent excavations have confirmed the drilling record, and the application of the churn type of drill to this work was considered successful.

Electric Lighting in Manchuria

By ALBERT W. PONTIUS*

THE South Manchuria railway maintains electric lighting plants at Dairen, Mukden, Changchun, Antung, and Liaoyang, and holds a controlling interest in the lighting plant at Newchwang, which is operated in connection with the waterworks at that port. All of these institutions seem to be giving fair business returns. Supplementary equipment, increasing the capacity by 1500 kw., has recently been added to the Dairen plant. The capacity of the lighting establishments at Antung and Changchun is also being increased, and an additional generator will be installed at the Liaoyang plant in the near future. The construction of an electric tramway and the enlargement of the railway lighting plant at Mukden are under discussion, but negotiations with the Chinese authorities have made little headway.

Recent statistics of lighting plants at main points along the railway give the number of households in which current has been installed as follows: Dairen, 6600; Mukden, 1200; Changchun, 1200; and Antung, 1250. Meters are installed only where five or more lamps are in use and the figures show that 32,000 lamps are supplied by meter in Dairen, 2300 at Mukden, 3400 at Changchun, and 2600 at Antung. Lamps supplied by monthly contract number 16,000 at Dairen, 4500 at Mukden, 3800 at Changchun, and 3600 at Antung. This is a healthy indication of the modernization of China.

*Dairen (Dalny), Japanese leased territory.

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Use of Hydrated Lime in Concrete Pavements

By ROBERT S. EDWARDS*

THE problem of building good roads, which our country as a whole is facing today, is without doubt serious and far reaching, and of as great economic importance as any problem of our modern times. There are a great many different types of roads being constructed throughout the United States. Some are of recognized standards and have given good service, while others are still in the experimental stage.

The problem to be solved in building good and permanent roads would seem, at first thought, to be an easy one, for we have many excellent road-making materials in practically every state in the Union, and there are many standard types of pavements which have stood the test of wear, tear, and time in a satisfactory manner in the past few years; yet, when we take into consideration the rapid evolution of traffic conditions, involving the ever-increasing use of motor-impelled vehicles, both light and heavy, together with quantity of traffic increase per year, our former idea of permanency in road construction must be changed to meet the present and cope with the future conditions of traffic.

It is not the purpose of this paper to touch to any great extent upon the different types of pavements and road building materials in use today; but it is its purpose to show wherein certain materials, when put together carefully and correctly, serve to make and meet, beyond any question of doubt, a pavement which has become a recognized standard under practically all conditions of cost, labor, and materials. Such a pavement, when properly laid, has demonstrated itself to be permanent under all varying conditions of traffic.

Concrete pavements meet all of the above requirements, but the concrete pavements of the future must be so put together in their making as to leave no room for doubt to even the most skeptical. It is in this putting together of a concrete to be used for a pavement that the manufacturer of hydrated lime is bound to find an increasing demand for his standardized hydrate.

Concrete as a Pavement.—In the choice of a suitable pavement, concrete has several distinct advantages which are of the greatest importance. In the first place, the materials or elements which go to make up concrete are to be found in every part of the country. Cement, a product of universal use, is manufactured in every part of the United States, and its cost is, generally speaking, reasonable. Good sand and gravel, or crushed rock, is also abundant, and can be had at low cost. Where sand is scarce and of inferior quality, it is possible to manufacture suitable sand from crushed rock or crushed gravel at a comparatively low cost. The labor and overhead charges cost practically the same for all classes

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of pavements laid, so that we have a general condition when dealing with concrete as a pavement that is very satisfactory.

After a careful study of the local conditions under which concrete pavements are to be laid, which includes careful examination and tests of the sand, gravel, or crushed rock, it is possible to draw up specifications that will insure good work. Careful superintendence and following specifications to the letter are of the greatest importance.

Use of Hydrated Lime in Concrete Construction.—In a great many parts of the United States, at the present time, hydrated lime has become favorably recognized and in considerable demand as a suitable product for mixing with concrete to make it dense, and thereby rendering concrete more waterproof. The addition of small percentages of hydrated lime, when making concrete mixtures, is immediately effective in promoting plasticity throughout the mass, thereby rendering the concrete more homogeneous and keeping it so during transit, before placing. After placing concrete which contains hydrated lime, its subsequent spading in the forms is greatly facilitated, and the thorough covering of all steel reinforcing rods is more perfectly accomplished. In fact, concrete mixed with a small percentage of hydrated lime seems to almost automatically fall into place.

The properties of plasticity and homogeneity, which small percentages of hydrated lime give to concrete, cannot be secured in any other possible way at so little added expense for the material used. On many large reinforced-concrete buildings which are being constructed in the United States today, the concrete is mixed at one or two central mixing plants, which are generally situated on the ground or in the basement of the building. After mixing, it is dumped into carriages and elevated, then distributed through galvanized iron pipes or chutes to the various parts of the building. It is a well known fact that portland cement, when mixed with water, is not very plastic, some brands of cement being extremely non-plastic, and while the mixture for reinforced building construction is a rich one (generally 1:2:4), yet even so, it is sometimes very difficult to secure sufficient plasticity in the concrete to insure its being elevated, poured, and distributed without considerable sticking and clogging of the pipes, attendant with more or less separation of the aggregate. An interesting example of the effectiveness of hydrated lime in correcting the last-named condition is well worth mentioning.

Hydrated Lime in Two Concrete Dams.—During the fall of 1912 and the winter of 1913, the Stone & Webster Engineering Corporation constructed a large concrete dam on the White Salmon river, about seventy miles from Portland, Oregon. Edwards & Lazell were retained by Stone & Webster and the Northwestern Electric Co., for whom the dam was built, to inspect the material used in the concrete work. A thorough investigation was made to determine the advisability of manufacturing the sand which was to be used, and it was finally decided to erect a large crushing and sand-manufacturing plant and secure both fine and coarse aggregate for the concrete in this manner. The sand was made by crushing a basaltic rock secured from the crusher situated on the bank of the stream at an elevation of 600 ft. above the river bed. The fine crushed rock was screened through ¼-in. mesh, and the fine and coarse crushed rock was stored

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in bins just above the mixing plant, from which point 80% of the concrete was poured down a spout or chute 400 ft. in length to the damsite below. From numerous test results it was decided to use 10% of hydrated lime throughout the concrete, the mixture being 1:3:6. It is more difficult to secure easy working concrete when using crushed rock as the coarse aggregate than when using gravel, this being due to the angularity of the crushed rock. In this case we not only had to contend with the crushed coarse aggregate, but sand-sized material was also angular, in fact, to such an extent that the concrete mixture would not flow down the steel-lined chutes without mechanical aid. By the addition of 10% of hydrated lime, or approximately 40 lb. of hydrated lime per yard of 1:3:6 concrete, we literally transformed the physical appearance of the concrete as seen in the chutes.

The concrete would first leave the mixers, pass into the chutes, and then onward without the slightest separation of the aggregate, and would finally arrive at the dam in a perfectly homogeneous mass, where it would flatten out to a level with but little shoveling and spading in the form. The hydrated lime, together with proper mixing, had given the concrete sufficient plasticity to overcome the excess friction caused by the angular condition of the fine and coarse aggregate, and formed a smooth-flowing, uninterrupted stream of concrete to be deposited in its final resting place in the dam.

Without the use of hydrated lime in this work, it was actually demonstrated that it would have been impossible to secure satisfactory results without discarding the conveying of concrete in chutes and instituting a far more expensive method of handling the concrete.

The writer has considerable data touching upon the use of hydrated lime in other important concrete structures, such as reinforced concrete conduits, floor slabs in building construction, concrete silos, and in lining tunnels with concrete, but it is quite satisfactory to have absolute record of its use in such important work as that noted above. Another instance where hydrated lime was used to great advantage and with considerable economy as compared to other waterproofing compounds considered for this work, should be mentioned before passing on to suggestions concerning its use in concrete when used for pavements.

In 1910 the Portland Railway, Light & Power Co. constructed a large hollow reinforced dam across the Clackamas river, some 30 miles from Portland. The construction of this type of dam was a new departure on the Pacific coast, and the work was undertaken with great care. The dam was 90 ft. high, over 600 ft. long, and hydrated lime was used in all of the concrete work which was to be exposed to water pressure. All of this work was of reinforced concrete, with reinforcing steel closely spaced on centres. The aggregate was carefully graded sand and gravel, concrete mixture being 1:2:4, with 7 to 10% of hydrated lime per yard of concrete added to the weight of the cement. The concrete as poured was plastic and homogeneous, and went into place with ease, while the finished concrete was uniform, dense, and absolutely impervious.

These specific records of the use of hydrated lime in the concrete work of two of the largest hydro-electric developments on the Pacific coast during the last four years, serve as convincing engineering proof which can

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be readily verified, that hydrated lime is a product of great intrinsic value and one that can be used with utmost safety in concrete work for the purposes named above.

Placing Concrete as a Pavement.—The utilization of concrete as a paving material during the last five or six years has developed into an important business, and is destined to become one of the greatest, if not the greatest, consumer of portland cement. Concrete pavements are found in practically all states in the Union, while various counties of several states have practically standardized this pavement. Notable among these is the county of Wayne, which takes in the city of Detroit, Michigan. Since the inception of concrete road building in Wayne county, about five years ago, over 70 miles of concrete pavement has been laid, and the county long ago adopted concrete as its standard pavement. As this county has placed more concrete pavements, and of necessity had more actual experience in handling concrete pavements, than any other section of the United States, it is interesting and instructive to know what their specifications call for and how experience has taught them to do their work.

1. Great care is taken in preparation of the sub-base. Experience has shown that more cracking in concrete pavements has resulted from improper and careless treatment of the sub-base than from any other one cause for cracking; consequently the sub-base is rolled hard and made as uniform as possible; also density is desired so that water seepage from the concrete into the sub-base may be diminished as much as possible.

2. Careful specifications for the sand, gravel, or crushed rock and cement are insisted upon and carried out to the letter. Careful proportioning and mixing of the concrete is also done.

3. During the last four years a gradual increase in the richness and thickness of the concrete has been specified, and the present specifications call for a 1:2:3½ concrete mixture, 7½ in. thick, for a one-piece concrete pavement.

4. Care in protection and covering all concrete after placing and keeping same covered for at least 10 days. This precaution is taken to prevent the loss of moisture by evaporation from the surface of the concrete.

5. The use of steel expansion joints cutting the entire depth of the concrete at each 25-ft. section, and filling in between these sections as formed with pieces of asphalted felt.

Placing and treatment of concrete pavements under the above specifications have produced results which are very satisfactory, and in carefully analyzing these specifications it would seem that every particle of engineering and common sense had been used. In practically every step in the process of laying the concrete it has been the intention to carry on the work so that future cracking may be eliminated, yet in spite of all these precautions, more or less cracking has been known to develop and is generally attributed to settlement of the sub-base or the movement of the concrete due to temperature changes.

Cause and Prevention of Cracking in Concrete Roads.—From my experience, gained in the testing of materials which go into concrete, as well as from experience acquired in the supervision of important concrete work and examination of so-called 'concrete road failures,' I do not believe that the fundamental causes for cracking in concrete pavements are temperature changes in the concrete or settlement of the sub-base alone. There are other primary

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and important reasons why these so-called temperature and settlement cracks develop at a later date, and until we take proper steps and exercise due care at the right time, we cannot greatly reduce this excess cracking.

No specification for the laying of concrete pavement, to my knowledge, has taken into consideration the chemical peculiarities shown by portland cement concrete in its preliminary setting and hardening periods. There has been no special provision for retaining to as large a degree as possible the actual mixing water first used in the concrete mixture. By careful treatment of the sub-base and protection of the finished surface of the concrete after pouring, it is the intention of the various specifications with which the writer is conversant, to retain in the concrete as much of this first mixing water as possible. While these precautions are a great help, they are not quite sufficient, as they rely to a great extent on treatment of surfaces to keep the water from leaving the concrete. The prevention of this leakage of water from concrete after the first few hours in which it is poured is an extremely important feature, and in this connection it is well to bear in mind that the reaction between a solid, such as portland cement, and a liquid, such as water, is a surface reaction, water only being able to react on the surface of the cement grain, and that owing to the slowness of the reaction and the insufficient amount of water being present, only a relatively small amount of the portland cement is at first decomposed by water. Consequently, if we can actually keep within the concrete mass what little excess mixing water we start with, or introduce into the concrete mass in the mixing some substance that contains and will readily hold excess water which the cement may secure later, we will accomplish what has not been done before.

There is no more important period in placing a concrete road surface than in the first 24 hours after pouring the concrete, for it is during this period that minute spots of weakness generally develop, due to the loss of water by leakage and evaporation and use of water by the cement in setting, causing contraction during the first 24 hours. Upon the later permanent hardening of the concrete, we do not secure a slab of as great cohesive uniformity as would be expected on first consideration.

The general conditions under which concrete pavements are placed are severe, as the majority of work is usually done in the dry spring and summer months when temperatures are high, causing excessive evaporation. The concrete is generally poured on an earth or clay sub-base in a thin slab varying between 4 and 7 in. thick. This condition alone makes it almost impossible to secure uniformity throughout the concrete mass, so that after hardening, the concrete road slab is subject to far greater variation due to the segregation of the coarse aggregate from the mortar, than is found in other forms of concrete work. This, of necessity, causes unevenness throughout the concrete, and the excessive cracking and raveling so often seen in poorly laid concrete roads is directly due to this fact.

It is the writer's opinion that the primary cause of cracking in concrete pavements is due to the loss or leakage of varying portions of the mixing water from the concrete by seepage through the sub-base, as well as in evaporation from the surface of the concrete, which leaves the concrete road slab in such a condition that at later times it will alternately absorb and give up water,

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depending on the season of the year, and that expansion and contraction of concrete and any movement in its volume is due infinitely more to this alternate wet and dry condition than to any temperature change from hot to cold without presence of moisture.

That the cracking which is directly attributed to the change in the condition of the sub-base, either in settlement spots or in drying out in shrinking, is primarily due to the above cause, which is greatly helped by unevenness and variability of the concrete mixture.

That there are few, if any, concrete pavements, individual slabs of which can be considered entirely uniform.

Hydrated Lime of Value in Concrete Pavements.—Hydrated lime is a product formed by the addition of accurate quantities of water to known weights of freshly burned quicklime, the finished material being a flour-like powder of great fineness and covering capacity, having more than twice the volume of the same weight of cement in its dry state.

The use of hydrated lime as a void filler in concrete mixtures, and for rendering concrete mixtures more watertight, dates back several years. Numerous tests show that a replacement of from 10 to 15% of cement by hydrated lime in rich concrete mixtures does not decrease the compressive strength of the concrete after three to four months time, and ultimately increases the strength and permanence of the concrete. It apparently makes but little difference as to its action as a void filler, whether the hydrate is manufactured from a dolomitic or high magnesium lime or a high calcium lime—it being necessary only to have a product which contains no free lime or unslacked particles. The proper hydration or dry slacking of lime reduces it to a finer degree of subdivision than can be accomplished by any mechanical means.

The amount of water required to convert the dry hydrated lime into a plastic paste varies from 50 to 70% of the weight of the lime; while to obtain a mortar of similar consistence with portland cement, an addition of 25 to 30% of water is required.

Unlike portland cement, however, the addition of water to hydrated lime does not create any chemical reactions. There is simply a lime paste formed which holds its excess water for a long time. Upon the addition of small quantities of hydrated lime, amounting to 10 or 15%, to the weight of cement used in concrete mixtures and the ordinary mixing of such mixtures, the hydrate, which has absorbed a large amount of water, corresponding to its weight, is thoroughly disseminated throughout the concrete mass, and, due to its fine plastic conditions, it is forced immediately into places in the concrete which the cement cannot reach.

Concrete, so mixed, on leaving the mixer, flows more readily into place and the coarse aggregate has much less tendency toward segregation in the concrete mass. In other words, the extreme finely divided condition of the moistened hydrated lime paste has increased, to a marked degree, the covering or spreading quality of the cement, and reduced, to a similar marked degree, the friction between particles of fine and coarse aggregate.

This answers the question of 'Why hydrated lime benefits concrete'—the action is purely a mechanical one, and can be compared to the oiling or greasing of a shaft or bearing. The property which hydrated lime has of absorbing and retaining large percentages of water, offers a ready solution to the problem of finding a means for keep-

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ing and holding moisture in freshly poured concrete pavements until the slower acting cement hardening process can utilize it.

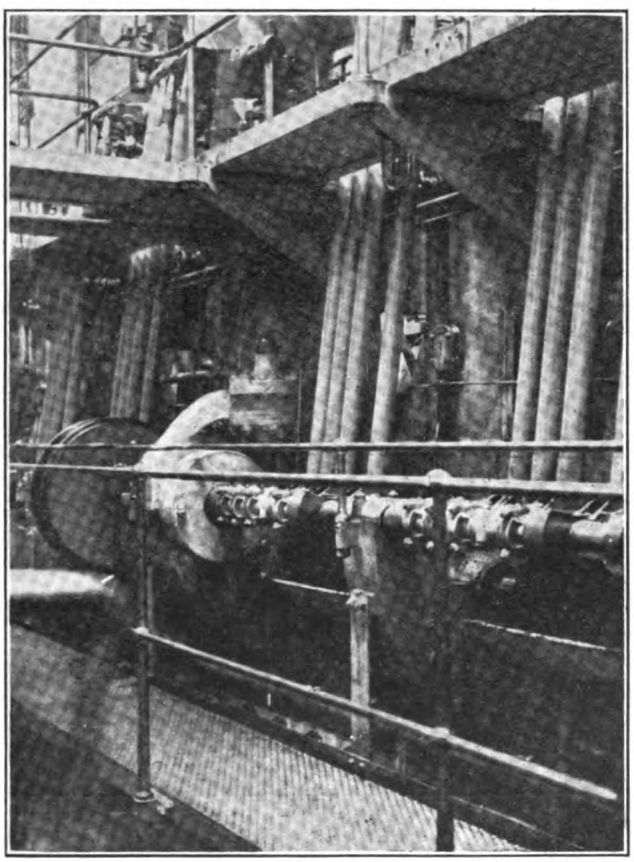
From a study of the foregoing data it is obvious that small percentages of hydrated lime, when added to concrete mixtures, in road work, will accomplish results which may be briefly summarized as follows:

1. Rendering the concrete highly plastic and homogeneous, thus producing density and uniformity in the finished concrete. This condition adds much to the life and efficiency of the road because of the uniform resistance to wear and other stresses.

2. Keeping a certain amount of excess moisture in the concrete while setting.

3. Rendering the concrete mass more nearly watertight and thereby preventing alternate wetting and drying out of the finished concrete.

4. In large pieces of work, the above properties given to concrete by hydrated lime would materially reduce the labor in spreading and bringing the concrete to a uniform surface, which is of great importance in paving work.



ENGINE ROOM, DIESEL MOTOR VESSEL 'SIAM,' SHOWING LAY SHAFT AND VALVE OPERATING GEAR.

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The Engineering Digest

DAMAGE BY WATER IN CALIFORNIA OILFIELDS*

Introduction

By F. McN. HAMILTON†

THE subject of conservation of natural resources is of vital importance. Flooding of oil lands by underground water is comparable to a loss of forests by a constantly burning fire, but is not so well realized except by persons directly employed in oil production. In order that the attention of the public, particularly non-resident owners of oil properties, may be directed to the menace of water entering and ruining the producing oil sands of the California fields it is proposed to state briefly and promptly the conditions existing in the various fields. Such statements will serve a more useful purpose if issued as the data are collected rather than to be published at the end of a year, with other information which is aimed to cover all branches of the industry.

The fact that a single field will be dealt with in each of these short reports must not be construed to mean that such a field is the only one in which serious conditions prevail. On the contrary, the menacing condition exists in many of our fields and the reason that separate reports will be issued is that valuable time may be saved to the industry.

All of these investigations made by the State Mining Bureau will be with the sole purpose of constructively aiding the industry. Operatives throughout the state are urged to assist by furnishing information when it is requested. It is my firm belief that the California oil men possess the ability to cope with the physical conditions, and the aim of the State Mining Bureau will be simply that of gathering the information gained by the experience of individuals, and placing it at the disposal of all.

Suggestions leading to improvement of this service will be welcome.

Coalinga Field

By R. P. McLAUGHLIN‡

The Coalinga field was visited in December, 1913, and the information gathered then, together with that obtained by personal experience during the past five years, furnishes the basis for this report. It is pleasant to record that the necessary assistance and information was cheerfully furnished by every person approached.

Water conditions in this field are no more serious than in some of the other important fields, which are to be described later when they are visited and the latest development noted.

Briefly stated, the oil sands of Coalinga are from 100 to 400 feet total thickness, lying in the form of more or less continuous sheets or strata which extend over a proved area approximately 15 miles long and 2 miles wide. The several sands making up the total thickness are separated by clay beds from 10 to 50 ft. thick. The dip of these formations varies from 20 to 40 ft. per 100. Over 1000 wells are producing at depths varying from 700 to 4000 feet. The wells cost from $4000 to $70,000 each. Similar to those beds carrying the oil are others

*Preliminary Report No. 1.

†State Mineralogist.

‡Assistant in Charge of Petroleum Department.

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bearing water. These water sands are sometimes above, below, or between the oil sands. When both water and oil sands are penetrated by a well, the water enters the oil sand. The water frequently forces the oil back into the sand so that pumping produces nothing but water. Besides the damage done at the well where the water first breaks in, it spreads to neighboring wells and causes their product to become partly or entirely water. The probability of such damage is usually foreseen and the method of its prevention is to insert screw pipe (or casing) in the well. It serves as the lining or wall of the well and if carried through and below the water sand and firmly landed in some sort of impervious stratum, such as clay, it prevents the water from leaking down into the well. Sometimes it is necessary to pump cement in behind the casing in order to thoroughly seal the passages down which the water might otherwise run. Several such lines (or strings) or casing are sometimes required inside the first one until they all resemble a telescope with the small end at the bottom of the well, in the oil sand.

The problem, therefore, has two separate branches: (1) determining where the casing should be landed, and (2) the actual work of placing it in a workmanlike manner in the well. Either of these branches is useless without the other.

As the oil and water sands are concealed from view by their great distance below the surface of the ground, record of the formations encountered in previously drilled wells is the only method of determining their position in new wells. Bearing in mind the size of the territory and great number of wells, together with the fact that natural underground connection transfers the damage from one well to another and eventually destroys the entire field, it will be seen that the problem of determining where new strings of casing should be landed may be fairly called a man-sized job. It can be done only by keeping accurate record of every well and patiently working out its relation to all those surrounding it. How this has been atttempted and the results obtained is the purpose of this writing.

Since February, 1913, the position of County Oil Well Commissioner for Fresno county has been occupied by a graduate engineer who has had a number of years' experience in the oil business. Appointment to this position is made by the county supervisors. The annual cost to the county is $2700 per year. The county derives one-eighth of its revenue from the Coalinga fields. Immediately after taking the position the Commissioner opened an office at a central location where he has collected and filed practically all of the well logs, along with numerous detailed drawings which he has made. Besides these, he has on file reports from various companies showing the percentage of water coming from their wells. These records are open to the inspection of operators, with proper safeguards for keeping confidential such records as do not concern the public. These records were freely opened to me as a representative of the State Mining Bureau and some of the following facts were ascertained from them:

There are about sixty superintendents in the field. Of these an overwhelming majority have actively co-operated with the Commissioner in his efforts to better conditions. In fact there has been but a single case of opposition and that from the representative of a comparatively small concern.

Attention is particularly directed to the following figures: West side field (total, 732 wells)—wells reported, 340; wells making 10 to 50% water, 68, 20% of those reported; wells making over 50% water, 13, 4% of those reported. East side field (total, 369 wells)—wells reported, 113; wells making 10 to 50% water, 29, 25% of those reported; wells making over 50% water, 4, 5% of those reported.

These figures show that of the 41% of the wells reported to the Commissioner there are 25% producing over 10% water. That the percentage would be higher if all the wells were reported there is little doubt.

The seriousness of the condition is well shown by the fact that I was informed by the president of one of the large operating companies that unless water troubles were remedied it would probably force his company to stop operations. Should such action become general, the field would be irreparably injured, as an idle well making water turns all of it into the oil-sands, upon which sands the life of the industry depends.

Here is one instance of how the damage works out in dollars and cents: A certain property has a well about 2700 ft. deep. It was drilled about three years ago at a cost of about $30,000. Initial production was over 200 barrels of oil per day and it has

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produced a total of about 100,000 barrels of oil, giving a profit of possibly $10,000. About a year ago water stopped this production almost entirely. The owners are financially unable to repair the well at present, and each day adds to the damage it is doing to surrounding property.

Fortunately, it has been actually demonstrated that there is a definite remedy for these conditions, which would otherwise mean the absolute destruction of the oil industry of California. For several years a number of men in this field have been ceaselessly working toward a means of applying the remedy. One of their results is that of having a man placed in the position of oil well commissioner, who systematically gathered and arranged evidence in a form useful to superintendents. Public opinion had to be led from the idea that nothing but a knowledge of the use of drilling tools was necessary or desirable, to the fact that gathering and correlating evidence is the prime necessity, supplemented by knowledge of practical methods. It is gratifying to those who advocated the plan in operation for the past year at Coalinga to be able to point to the following actual demonstration that it gets good results.

Three operating companies in the Coalinga field were troubled with water in a group of wells. Each one thought that his own wells were perfect and that one or both of the neighbors had wells which were flooding the entire group. The idea was so strong that it finally became a personal matter between the superintendents, who ceased to exchange information. Finally, a plan of arbitration was adopted as being the only solution. Each of the three arbitrators was a successful operator in charge of property. The Commissioner's file of records was not at that time complete and the board had to make some investigations to supply such information as his office can now fully furnish.

Under the direction of this board work was done by the three companies and in four months' time the trouble was absolutely cured. It was caused principally by one well where chemical action of the water had eaten through the casing which had originally shut out the water. A single hole ½ in. diameter had flooded six wells.

The important lesson taught by this board is that their first steps in the work were: (1) Collecting from the three superintendents all the available information relating to the history of all the wells; (2) an accurate sampling of the product of each well (two or three were pumping water only and several others were making about 50% water); (3) making drawings of all the well logs showing the relative positions of all the underground formations and the various strings of casing.

Then they directed the three companies what repairs and experimenting they must perform on the wells. They did not themselves do any of the actual work of repairs nor even specify in detail how it should be done. Their work was entirely advisory and they were backed up by a contract which insured that their advice must be followed.

If the accomplishments of such a system as is in operation at Coalinga were limited to simply remedying the damage done by water it would pay for itself many times over, but besides this it gives promise of other benefits measured in dollars and cents. Already the work of the present Commissioner has convinced some operators that some of their wells have passed through oil sands which were not recognized as such; and they will probably now go back and test these sands with the expectation of finding more oil than their first calculations indicated. It has also definitely shown that water occupies the same sands that farther up their dip have produced oil, and that as the oil is removed the water gradually creeps upward along the stratum, making it necessary to shut off this particular bed to prevent its flooding the other sands which have not yet been drained of all their oil content. This phenomenon of gradual encroachment is known as edge water and it must be intelligently dealt with.

Conclusions drawn by me from the evidence already outlined are as follows:

Responsibility for the serious damage by water rests upon two groups of people, namely, superintendents in the field, and company officials to whom they report. Any operator is liable to deceive himself as to the conditions of his property. It is the concensus of opinion of the operators in the field, that a superintendent who personally refuses to exchange information on underground conditions with all of his neighbors and with the county oil well commissioner, is not fitted to hold the position. Company officials who do not take the trouble to satisfy themselves that their superintendent does

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these things, in an open minded and fair manner have no grounds for complaint if their property is ruined, and furthermore, they are in the same position toward the community as a man would be, should he deliberately allow his house to catch fire where it would certainly burn three or four others belonging to neighbors.

Some of the problems that remain to be solved by the operators in the Coalinga field are as follows:

(1) The exact location of the beds and the composition of their contained water which destroys both steel and iron casing in from two to five years. At present it seems probable that it is the so-called 'black sulphur water.'

(2) The possibility of coating casing with paint or cement that will resist the chemical action. This may be difficult to accomplish, as the friction in placing the casing will tend to scrape off any coating. However, experiments should be tried, as some may succeed and none will be harmful.

(3) The possibility that some metal or alloy may be better than that used in the casing at present on the market.

(4) Means should be provided whereby the Commissioner will be informed of the amount of water in all the wells in the field.

(5) A means of co-operation among all the superintendents and officials is desirable and will repay all those taking part. Such an end will be accomplished by continuing the meetings of the Coalinga Oil Men's Association, which meets for discussion of problems of interest. At each meeting a paper has been read by some man of experience.

(6) It will be necessary to provide some means whereby wells belonging to a financially embarrassed company may be repaired and also to force, preferably by arbitration, some operators to repair their wells.

A movement is under way to combine the various operators under a contract similar to that above referred to in the arbitration. By this means they can repair damage occurring on their own properties, and some of the largest operators are confident that the law affords ample relief for damage done by operators who refuse to enter into the contract. It seems impossible that any operator should decline to coöperate.

Cost of Concrete Road*

IN the following itemized table the compiler, B. P. Lampert, county engineer, Emery, Ia., gives the cost of building a concrete road at Fort Dodge, Ia. Points to be taken into consideration when studying the data are: (1) Average haul, 2½ miles; (2) sand not screened and not charged; (3) engineer's time included, also 1-5 cost of plant used.

Total amount laid, 9472 sq. yd. Approximately 3100 cu. yd. of grading (cut and fill).

LABOR ON CONCRETE

Based on average organization and average rate of 500 sq. yd. daily.

Job.	No. of men.	Cost per day.	Cost per sq. yd.
Finishing and removing forms..	2	$ 8.00	$0.0160
Striking off concrete	2	5.50	0.0110
Fireman on mixer	1	3.50	0.0070
Engineer on mixer	1	4.00	0.0080
Side forms and joints	2	6.00	0.0120
Cement	1	3.00	0.0060
Wheeling and shoveling sand.	2	5.50	0.0110
Wheeling stone..	3	8.25	0.0165
Shoveling stone..	6	16.50	0.0330
Extra, fixing subgrade	1	2.75	0.0055
Water boy.....	1	1.00	0.0020
Hose boy.....	1	1.00	0.0020
	23	$65.00	$0.1300

MATERIAL AND HANDLING SAME.

Job.	Total cost.	Cost per sq. yd.
Grading: wheel scraper and		

*Abstract from *The Canadian Engineer*, Dec. 25, 1913.

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wagon work..$ 497.25			
Loading wagons. 60.00			
		$ 557.25	$0.0588
Surfacing		307.50	0.0325
Baker joints and felt		536.40	0.0566
Sand, 874 cu. yd., taken from pit:			
Stripping pit..	60.00†		
Loading	129.50		
Hauling	243.00		
		372.50	0.0393
(Cost per cu. yd., $0.426).			
Crushed stone, 560.74 cu. yd.	560.74		
Freight	285.00		
Loading	141.45		
Hauling	341.00		
		1,328.28	0.1405
(Cost per cu. yd., $2.37.)			
Gravel, 885 cu. yd.	595.04		
Freight	403.02		
Loading	123.50		
Hauling	493.00		
		1,614.56	0.1705
(Cost per cu. yd., $1.89.)			
Cement 2,413 bbl. at $1.56 on cars.....	3,764.28		
Hauling	217.17		
		3,981.45	0.4203
Total		$8,697.94	$0.9183
GENERAL CHARGES			
Freight on mixer, both ways.....$184.94			
Engineer	49.70		
		$ 234.64	$0.0247
Misc. teaming.....		71.43	0.0075
Oil, coal, gas, repairs		60.55	0.0064
Misc. labor, unloading mixer, laying pipe, building culvert, lost time, etc.		176.69	0.0187
Engineering and foreman		125.00	0.0132
One-fifth of cost of plant		105.00	0.0111
		773.31	0.0816
Totals, all expenses....		$10,750.72	$1.13

†Not included in calculating cost.

Federal Power on Federal Lands

THE contention of the Government that power companies can not secure rights of way across national forests without complying with the regulations of the secretary of agriculture has been completely sustained, according to the officers of the forest service, by the opinion of the circuit court of appeals filed on November 14 in the case of the United States *v* the Utah Power & Light Company. In its decision, the court announces that Congress has assumed complete control of the water-power question, so far as the public lands are affected, and that a state in the exercise of its sovereign authority can not interfere with or transcend this constitutional power of Congress.

Since December 15, 1900, the Utah Power & Light Company has operated its hydro-electric power works on certain public lands the state of Utah now forming a part of the Cache national forest, and the United States sought to enjoin this occupancy until the Company should comply with the provisions of the Act of May 14, 1896. The power company alleged that its rights were secured and protected by the Act of July 26, 1866, now Section 2339 of the Revised Statutes.

The decision holds that the Act of May 14, 1896, empowering the Secretary of the Interior to permit, under general regulations to be fixed by him, the use of, or rights of way upon, the public lands and national forest reservations for the purpose of generating, manufacturing, and distributing electric energy, repeals the Act of July 26, 1866, in so far as it related to the subject of generating and distributing electric power and that the Company must acquire its rights of way in accordance with the provisions of the later act.

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The court denies the Company's contention that it was protected in its tenure because that tenure was authorized by the laws of the state of Utah, exercising sovereign and exclusive jurisdiction with respect thereto. On this point the court says:

"The proposition that absolute and perpetual rights in the public lands may be acquired for private gain by mere appropriation, without purchase or compensation, and in the exercise of a state sovereignty which transcends the constitutional power of the Congress, is a somewhat startling one. * * * * * * * The constitution of the United States provides that 'Congress shall have power to dispose of and make all needful rules and regulations respecting the territory or the property belonging to the United States.' This is the supreme law of the land and embodies an express grant of power to the national government. It has been construed to mean that title and rights in and to the public lands are created by the acts of Congress, and must be governed by their provisions whether they be hard or lenient, and that no rights whatsoever can be obtained in the lands of the United States except as Congress may consent."

It holds that in the express stipulation of the act enabling the people of Utah to form a constitution and state government, they forever disclaimed all right and title to the unappropriated public lands within the boundaries of the state, and until the title to these lands has been disposed of by the United States, the same shall be and remain subject to the disposition of the federal government. This provision was later adopted by and incorporated in the constitution of the state of Utah, thereby becoming a part of the organic law of the state, and it secured to the United States full control of the public lands within the limits of the state.

Speaking of this supremacy of power the court says:

"That a power may be injuriously exercised is no reason for a misconstruction of the scope and extent of that power. The government of the United States has shown no disposition to .deal unjustly with the states, nor with their citizens in this respect. We must conclude, therefore, that the power of Congress to dispose of and make all needful rules and regulations respecting the territory, or other property belonging to the United States, including rights of the nature here involved, is supreme; and in conferring upon the Secretary of the Interior power to establish such rules and regulations as may be necessary to supplement its legislation, Congress acts within its constitutional power. The exertion by Congress of a power which is granted in express terms must supersede all legislation over the same subject by the states."

The decision holds that the Act of July 26, 1866, constitutes no grant of specific rights by the Congress of the United States and that,

"In view of the express power conferred upon Congress by the constitution, and reserved to it by the organic law of the state of Utah, it can not be successfully urged that such legislation committed the government to a policy that should be irrevocable."

Further, the later Act of 1896 and the rules and regulations promulgated thereunder, by making specific and comprehensive provisions respecting a subject, such as the generation, manufacture, and distribution of electric power, withdraws that subject from the operation of the prior act of 1866 to the extent to which it is governed by such special provision and is a substitute for and a repeal of the general statute which formerly governed. In this connection, the decision holds that:

"Control over the disposition of the public lands, and all rights and interests therein, remain unimpaired in the Congress. Evidently that body perceived that the time had come when changed conditions and the complex interests and relations of our national life demanded that, with respect to this particular form of industry the application of the former act, as worded and construed, should be modified and restricted; therefore, it enacted the subsequent legislation.

"There can be no doubt that Congress intended to and did assume complete control of the subject-matter, and made and authorized specific and comprehensive provisions respecting it. This appears not only from the act in question, but from other legislation connected therewith and supplemental thereto. * * * * * *

"The result is that whatever rights to burden the public lands may have been recognized or confirmed by Section 2339 of the Revised Statutes, those involving the generation, manufacture, and distribution of

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electric power have been withdrawn, modified and restricted by the subsequent act of May 14, 1896. This later legislation became effective prior to the initiation of appellee's claim. The Power company has not availed itself of the provisions of this later statute; therefore, its rights, if any, are subordinate to those of the government."

The Approximate Melting Point of Some Commercial Copper Alloys

As very little information on the melting points of commercial brasses and bronzes can be found in either scientific or technical literature, tests of a few typical alloys were made by H. W. Gillett and A. B. Norton of the U. S. Bureau of Mines. The results, summarized, in Technical Paper No. 60, are as follows:

The melting point given is the 'liquidus,' or point where the alloy is completely molten. The temperatures are thought to be accurate within plus or minus 10°C. or plus or minus 20°F.

Copies of this technical paper may be obtained by addressing the Director, Bureau of Mines, Washington, D. C.

Alloy.	Approximate composition. Copper.	Zinc.	Tin.	Lead.	Melting point. Deg. C.	Deg. F.
Gun metal	88	2	10	..	995	1825
Leaded gun metal	85½	2	9½	3	980	1795
Red brass	85	5	5	5	970	1780
Low-grade red brass	82	10	3	5	980	1795
Leaded bronze	80	..	10	10	945	1735
Bronze with zinc	85	5	10	..	980	1795
Half yellow-half red	75	20	2	3	920	1690
Cast yellow brass	67	31	..	2	895	1645
Naval brass	61½	37	1½	..	855	1570
Manganese bronze	..	..	..	..	870	1600

Flow of Water Through Concrete

Results of great importance to contractors, engineers, and farmers who have to do with concrete construction are being obtained in a series of tests to determine the rate and the amount of flow of water through concrete. The College of Engineering of the University of Wisconsin is making these tests with the object of finding a simpler means of making concrete water-tight. A large cement company in the Middle West is coöperating with the college by offering the facilities of its plant.

Already some interesting results have been gotten in the effect of the length of the time of mixing in a machine mixer of the batch type; the effect of the percentage of mixing upon the imperviousness of the concrete; the effect of having sand in dry condition before mixing; and the effect of having the sand wet.

The experimenters have found that good results are obtained if the concrete remains in the mixer from two to three minutes when dry materials are employed. For cases where the sand and gravel or stone are damp, a considerably longer time is required. Therefore the use of wet sand should be avoided if possible. The experiments showed that mixtures consisting of 1 part of cement, 1½ parts of Janesville sand of the torpedo grade, and 3 parts of Janesville gravel, when mixed to a wet consistence, are impervious to water when subjected to a pressure of 40 lb. per square inch. Mixtures as lean as 1 part of cement to 6 parts of gravel (a graded mixture) have been made impervious at high pressures by using care in proportioning the amount of water and in mixing the batch. The specimens used in making these tests are cylin-

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drical in form and so made that the faces of the cylinders, which are 13½ in. diameter, are exposed to the predetermined water pressure. The thickness of the concrete through which the water must pass can be varied from 4 to 18 in. Ample provision is made for cleaning both faces of the cylinder before placing it upon the testing apparatus. The apparatus itself is so arranged that accurate tests can be made and the results readily recorded.

The importance of these experiments will be more sufficiently appreciated when it is understood that a large proportion of the trouble arising from poor concrete is due to the use of defective sand or gravel.

The department is also studying the effect of varying the percentages of cement and water, the gradation of the sand and gravel (by this is meant the size of the rocks and the fineness of the sand), the proportioning of the mixture, the thoroughness of mixing, and the effects of different conditions on the hardening of the specimens. Results will be announced when determinations have been made.

The Extent of Mineral Waste*

By JOSEPH A. HOLMES

IT is a reasonable estimate that the present waste, in large measure unnecessary, of mineral resources amounts to a national loss of not less than $1,000,000 a day.

In one respect at least a consideration of the mineral wastes has a basis quite different from the consideration of agricultural wastes. Our crops represent an annual production from a reasonably permanent soil; our forests may grow again, though a much longer period of time is required; and the soils themselves may be reproduced from the subsoil and the rock beneath. But of our mineral resources we have only the one supply. This supply is to a considerable extent destroyed in use; and at the present increasing rate at which we are using and wasting it our one supply will be either exhausted or largely depleted while the nation is yet in its youth.

The most urgent need for investigation and reform is in connection with the unnecessary waste of oil and natural gas that still prevails in many parts of the country. Even with the limited facilities at its disposal the bureau has been able during the current year to stop a waste of natural gas valued at not less than $10,000,000, an amount that exceeds by six times the total cost of the bureau's investigations to date. There is urgent need of enlarged facilities with which to push this work more rapidly. A few years of further delay and this valuable source of national wealth will have been wasted—permanently lost.

The individual operators in causing this waste have followed their natural bent for temporary gain. The states have permitted this criminal waste without protest, fearing that interference might retard development. Will the National government do the same? The saving already accomplished was the result of inquiries and researches that enabled the engineers of the bureau to demonstrate to the oil and gas men in one of the Oklahoma fields that much waste of gas could be prevented without stopping the drilling for oil.

If the funds at the disposal of the bureau had been large enough to provide for more extended investigations and demonstrations, the prevention of waste would have been much greater. As it is, however, in many parts of the Oklahoma oil and gas fields the waste of natural gas that still continues is equivalent to $15,000,000 to $20,000,000 per annum, and this waste in all of the oil and gas fields of the country now aggregates more than $50,000,000 per annum. Of the total waste of gas in the different oil fields of the country more than 80% is believed to be easily preventable. As regards the remaining 20%, it is believed that gasoline may be extracted from much of it and the gas itself burned for some useful purpose.

The need for enlarged investigation is further shown by the fact that in addition to this waste of gas the waste of petroleum, and especially the loss of the lighter oils, in pumping and storage is much greater than is ordinarily supposed. Moreover, the injury caused in a number of oil fields through the flooding of oil and gas strata by underground water is another phase of

*From the forthcoming third annual report of the National Bureau of Mines.

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the subject calling urgently for inquiry and investigation.

It is estimated that the proposed investigations into the waste of oil and gas would cost from $30,000 to $40,000 per annum, and it is believed that the saving to the national wealth would be more than a hundredfold for each dollar expended in such an investigation.

The waste in coal mining is another drain on our national wealth which calls for serious and extended inquiry and investigation. A preliminary estimate, based upon limited inquiry and examination, indicates an annual waste or loss of coal in mining and handling of not less than 250,000,000 tons per annum. This represents a loss from our best and most easily mined coals and those nearest our great centres of industry. What is needed in connection with this loss is a thorough underground survey and examination at certain carefully selected areas in each of the important coal fields of the country, with a view to determining the exact conditions under which mining operations take place and the possibilities of adopting less wasteful methods. With this large amount of accurate information laid before the public, it will then be possible to obtain the adoption of far less wasteful methods of mining. Such an investigation, thoroughly conducted, would cost about $50,000 per annum for three or four years. It is confidently believed that the results of such an investigation would mean a saving in fuel resources having a value to the nation of considerably more than $50,000,000 per annum, a sum that cannot be lightly disregarded.

There is need of similar investigations looking to a reduction in the wastes or losses in the mining, preparation, and treatment of our metalliferous ores and metals, which wastes and losses aggregate in different cases from 10 to 50% of the total yearly production of such minerals and metals. A few of these wastes may be regarded as representing to some extent a deferred use of the materials. These it is not now proposed to investigate. Many others represent a total and permanent loss, and in the majority of our metals this reduction in our national supply will at no distant date become a serious problem. Certain investigations relating to both safety and waste in connection with our metal mining and metallurgical operations are already under way, but they are quite inadequate to meet the need for investigations in these branches of the mineral industry.

Oil-Bearing Territory Near Oroville, California

An investigation by the U. S. Geological Survey of supposed oil territory near Oroville, Cal., has given negative results, the oil showing on the surface of water having been found to be caused by the presence of iron oxide.

The so-called oil seeps in the vicinity of Oroville, about which some inquiries have been made, prove to be mainly stains of iron and are not indications of petroleum, according to geologist R. W. Pack, of the Survey, who examined them in December, 1913. These 'seeps' occur on the gravel-covered mesa that lies on the north side of Feather river opposite the city of Oroville. They consist of bright iridescent colors on the surface of small pools of water and of dark stains on the ground, mainly near such pools. The colors are caused by a film of iron oxide on the surface of the water, which produces an appearance similar to that formed by a small quantity of oil. It may be distinguished from an oil film by the fact that it is readily broken into small fragments when the pool is gently stirred, whereas the colors of an oil film reappear unbroken when the pool is again quiet. Pools covered by such a coating of iron oxide are plentiful and are especially noticeable in the old gravel mines north of Oroville. The black stains on the ground are similar to those appearing about small pools in almost any undrained area. They contain no trace of oil.

Beneath the gravel that covers the mesa north of the river are beds of sand and clay that contain some carbonaceous matter which locally forms small beds of coal. Small amounts of gas or even traces of oil occur in beds of this type in many parts of the world, and such small pockets of gas as were found in the well drilled to a depth of 1000 ft. about 5 miles north of Oroville probably occur scattered through the beds. It is very improbable, however, that larger bodies of oil or gas will be found here.

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Portland Cement Production 1913

ALTHOUGH few definite statements as to selling prices are at hand, it is evident, according to the U. S. Geological Survey, that the average value per barrel was appreciably higher than in 1912. Increases of 10 to 25c. per barrel are reported from several plants in the central and eastern states, but there were slight decreases reported from a few plants in the Rocky Mountain district. Two new plants, both in Washington, were added to the list of producers during 1913. The following table gives, by commercial districts, the estimated production, shipments, and stocks for 1913 and the actual production, shipments, and stocks for 1912:

	1912.	Estimate, 1913.
Lehigh District (eastern Pennsylvania and western New Jersey).		
Production	24,762,083	27,079,000
Shipment	26,013,891	26,734,000
Stock	1,927,495	2,332,000
New York State.		
Production	4,492,806	5,208,000
Shipment	4,543,060	5,239,000
Stock	555,989	430,000
Ohio and Western Pennsylvania.		
Production	7,359,402	7,704,000
Shipment	7,398,753	7,302,000
Stock	640,672	1,027,000
Southeastern States (Ala., Ga., Md., Tenn., Va., W. Va.).		
Production	4,737,257	5,724,000
Shipment	5,081,209	5,492,000
Stock	348,182	623,000
Southern Indiana and Kentucky.		
Production	3,091,603	3,006,000
Shipment	3,134,841	2,861,000
Stock	285,422	437,000
Illinois and Northwest Indiana.		
Production	10,659,357	12,406,000
Shipment	10,677,479	11,566,000
Stock	1,106,547	1,942,000
Michigan and Northeast Indiana.		
Production	4,308,645	5,065,000
Shipment	4,417,808	4,967,000
Stock	515,619	609,000
Iowa and Missouri.		
Production	7,583,933	8,427,000
Shipment	7,804,901	7,962,000
Stock	893,720	1,363,000
Great Plains States (Kan., Okla., and Central Texas).		
Production	5,807,043	6,200,000
Shipment	6,174,085	6,090,000
Stock	708,657	789,000
Rocky Mountain States (Colo., Utah, Mont., Ariz., and Western Texas).		
Production	2,299,252	2,671,000
Shipment	2,234,602	2,568,000
Stock	222,037	312,000
Pacific Coast States (Cal. and Wash.).		
Production	7,336,715	8,916,000
Shipment	7,531,927	8,072,000
Stock	606,989	1,511,000
Total.		
Production	82,438,096	92,406,000
Shipment	85,012,556	88,853,000
Stock	7,811,329	11,375,000

Oil Shales of Utah and Colorado

BEFORE the discovery of the great subterranean petroleum pools in various portions of the United States about the time of the Civil war, the extraction of oil from bituminous shale was a considerable and growing industry. In 1860 there were more than 20 shale-treating plants in operation, but by 1865 the cost of producing petroleum was so much less than that of producing the artificial oil that the owners of shale plants were either forced out of business or compelled to ally themselves with the petroleum industry, some of them becoming refiners of crude petroleum. Interest is now revived in the matter by a preliminary report of the U. S. Geological Survey on the oil-bearing qualities of the extensive deposits of bituminous shale in northwestern Colorado and northwestern Utah, and the fact that Secretary Lane has had under consideration the advisability of withdrawing from entry large areas of public lands containing these shale beds, which are of undoubted ultimate economic value.

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Notwithstanding the facts that the world's production of petroleum was never so great as at present and that last year's production in the United States was a record breaker by an increase of 10,000,000 barrels, yet the improved methods of handling oil-bearing shale by which not only oil but ammonia salts and other valuable by-products are extracted, have rendered the deposits of bituminous shale in Colorado and Utah well worthy of consideration. Field and laboratory tests of these shales by the Geological Survey indicate an oil content of 10 to 61 gallons a ton, with a probable average for the better grades of shale of a barrel to a ton, though this average may not hold for extensive deposits of the rock. No tonnage estimate of the bituminous shales is attempted in a forthcoming report of the Survey, but observations have been made of their occurrence in various localities in Colorado and Utah as well as in Wyoming and Nevada during the last seven or eight years of geologic field work in these states, and it is known that their acreage is very great, and in many places beds of generous thickness have been found.

With only incomplete data at hand the Geological Survey considers the present cost of producing crude oil from these bituminous shales as probably above the current price of petroleum, even taking into consideration the valuable nature of the by-products. The great latent possibility of these resources, however, is fully realized. In fact, in any European country other than Russia or Rumania, which are rich in petroleum lands, these large areas of bituminous shale would possess immediate utility. Furthermore they would be regarded as of large importance as a war resource for naval use. The American deposits are situated inland, where operations would not require guarding in time of attack, and they constitute a resource which can be estimated both as to quantity and quality as accurately as a coal bed, whereas their competitor, natural petroleum, is variable in both these respects and its production is uncertain.

Secretary Lane has, however, after careful consideration, decided not to recommend to the President at this time the withdrawal of these lands, because of his belief that such action might possibly result in retarding or prejudicing the development of a new mining industry in these portions of Colorado and Utah, especially at this stage, when private initiative needs every inducement to test out the real value of the resources. Although the oil shales are undoubtedly a valuable reserve resource, being capable of furnishing a large and reliable supply both of fuel and of fertilizing material in the form of ammonia salts, there would seem to be no urgent public need for withdrawing the land from prospecting and acquisition under the existing laws, which are believed to be fairly adequate to meet the present needs of this prospective industry. In dealing with a resource whose present value is somewhat conjectural, both as to market and as to cost of production, it seems wise to avoid placing any possible hindrance whatever in the way of private enterprise at the initial stage of development, and to favor utilization by offering to real producers every premium that the present law affords.

It is probable, however, that the Geological Survey will make a more detailed examination of the Colorado and Utah shales and possibly the Bureau of Mines may take up technologic studies related to their utilization. Although, as stated, the oil-shale industry long since ceased in the United States, it has persisted and apparently flourished in Great Britain and France. In 1904 the production of oil shale in Scotland amounted to 2,709,840 tons with a content of 63,000,000 gallons of crude oil, yielding marketable products of 2,517,296 gallons of naphtha, 16,991,748 gallons of burning oil, 37,997 tons of gas oil, 39,487 tons of lubricating oil, 22,476 tons of paraffin wax, and 49,600 tons of ammonia salts. In 1913 the production of oil shale in Scotland was 3,150,000 tons, from which about 65,000,000 gallons of oil was obtained and also a large amount of ammonium sulphate. This yield of 20 gallons of oil to the ton of shale may be contrasted with the assumed average yield of 40 gallons from the Colorado and Utah shales. The cost of mining and treating the shale in Scotland for both oil and by-products is said to be about $1.85 a ton.

Especial interest attaches to the deposits of oil shale in the United States because of the recognition by Great Britain of the value of these deposits, and the reported purchase last year by the British Admiralty of a large tract of oil-shale land in New Brunswick, to be used exclusively as the

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source of oil for the British Navy. Lord Winston Churchill estimates that the Scottish shale deposits are capable of an annual output of 400,000 to 500,000 tons of fuel oil during the next 150 years, which will be an important addition to the world's supply.

The report on the oil shales of Colorado and Utah, when issued, may be obtained from the Director of the United States Geological Survey, Washington, D. C., but it will not be printed and available for three or four months.

San Francisco Municipal Railway Extensions*

By M. M. O'SHAUGNESSY

THE exact routes which have been decided upon for the street railways which are to be constructed under the bond issue authorized August 26, 1913, the progress made in the construction of these street railways, when they will be placed in operation, what number of persons can be carried to or from the site of the Panama-Pacific Exposition by these street railways, and whether the transportation so furnished will be sufficient are embodied in the following report:

The Van Ness avenue and Chestnut street railways, which will be the first completed, will be placed in operation on or before September 1, 1914, and the Church street line, if all proceedings for opening that street are expedited by the Supervisors, which will be the last to be finished, will be placed in operation on or before February 1, 1915.

Ninety per cent of the material necessary for the construction and equipment of the street railways has been ordered and is now in process of manufacture. The remainder of the material will be ordered within 30 days.

The carrying capacity of the proposed street railways will be limited by the number of cars operated. With the 100 cars which it is proposed to purchase and the 43 cars now owned by the city a maximum of 19,125 persons per hour can be transported to or from the Exposition.

The transportation so furnished will be sufficient during days of average attendance at the Exposition, provided passengers are willing to put up with some slight discomfort during the hours of heavy traffic owing to the crowded condition of the cars. It will be entirely inadequate during special days when the attendance is in excess of 100,000 persons.

The bond issue authorized August 26, 1913, provided the sum of $3,500,000 for the construction and purchase of double track street railways aggregating 16.35 miles in length, together with the equipment necessary therefor.

The streets upon which the proposed street railways are to be constructed, the dates upon which work will be commenced and the dates when the street railways will be finished and the lines placed in operation are as follows:

Van Ness Avenue Line—

To be constructed on Van Ness avenue from Market street to Chestnut street, length 1.89 miles; work will be commenced not later than April 15, 1914, and completed on or before September 1, 1914.

Chestnut Street Line—

To be constructed on Chestnut street from Van Ness avenue to Scott street, thence on Scott street to Greenwich street, thence on Greenwich street to Steiner street, thence on Steiner street to Union street, where connections will be made with the tracks of the Union street line; length 1.22 miles; work will be commenced not later than April 15 and be completed on or before September 1.

Potrero Avenue Line—

To be constructed from Market street and Van Ness avenue, across Market street to Eleventh street, thence along Eleventh street to Division street, thence along Division street to Potrero avenue, thence along Potrero avenue to Twenty-fifth street; length 1.99 miles; provided there is no delay in the proposed widening of Division street from Seventh to Sixteenth streets, work on this line will be commenced not later than June 1 and will be completed on or before October 1.

*Abstract from *Municipal Record*, Feb. 5, 1914.

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Union Street Line—

The property of the Ferry & Presidio Railway Company was acquired during December, 1913, and placed in operation as a municipal railway on December 11 last. This street railway is operated along the Embarcadero from the Ferry to Jackson and Washington streets, thence to Columbus avenue, thence on Columbus avenue to Union street, thence out Union street to Larkin street, thence to Vallejo street, thence to Franklin street, thence to Union street, thence out Union street to Baker street, down Baker street to Greenwich street, thence on Greenwich street to the Presidio Military Reservation. The total length of this line is approximately 3.9 miles, of which slightly over ½ mile will have to be reconstructed. It is expected to commence this reconstruction not later than August 1, and complete it on or before December 1.

Columbus Avenue Extension to Union Street Line—

To be constructed on Columbus avenue from Union street to North Point street, thence on North Point street to Van Ness avenue, thence on Van Ness avenue to Chestnut street, where connections will be made with the tracks of the Van Ness avenue line; total length 1.26 miles. Work on this extension will be commenced not later than June 1 and completed on or before November 1.

Fort Mason Extension to Union Street Line—

Connection is to be made with the tracks of the Columbus avenue extension to the Union street line at Bay street and tracks are to be constructed through the Fort Mason Military Reservation to a terminal on Laguna street between Jefferson and Beach streets; total length 0.48 mile. Work on this extension will be commenced not later than August 15 and completed on or before October 15.

Stockton Street Line—

To be constructed on Stockton street from Market street to Columbus avenue, where connection will be made with the tracks of the Union street line; total length 0.97 mile. The construction of this street railway is dependent upon the completion of the Stockton street tunnel. At the present time it is the expectation that work can be commenced not later than August 1 and completed on or before November 1.

California Street Line—

To be constructed as an extension to the Geary street line. Tracks will be laid on Second avenue from Geary street to Cornwall street, thence on Cornwall street to its junction with California street at Fifth avenue, thence on California street to Thirty-third avenue; total length 2.1 miles. Work will be commenced not later than September 1 and be completed on or before January 1, 1915.

Church Street Line—

To be constructed from Market street and Van Ness avenue out Market street to Church street, thence on Church street from Market street to Thirtieth and Church streets; total length 2.54 miles. The construction of this street railway is dependent upon the construction of the Mission boulevard, which has been designed at the request of the adjacent property owners to overcome the steep grades of Church street between Eighteenth and Twenty-second streets. It is the present expectation that work on this street railway will be commenced not later than September 1 and completed on or before February 1, 1915.

Contracts contemplating the expenditure of $871,811.04 were entered into on January 2 for the following materials and equipment to be used in the construction of the street railways:

The amount named opposite each contract includes the contract price and the bonus which the contractor may earn by delivering the material before the date specified.

Contract No. 1, with the United States Steel Products Co., for steel rails and rail joints.....	$150,014.22
Contract No. 2, with the Payne Bolt Works, of San Francisco, for tie rods	3,514.50
Contract No. 3, with Eccles & Smith, of San Francisco, for tie plates	15,264.32
Contract No. 4, with the United States Steel Products Co., for rail spikes	2,550.00
Contract No. 5, with the Caspar Lumber Co., of San Francisco, for redwood ties	37,990.00
Contract No. 7, with the United States Steel Products Co., for track special work	94,338.00
Contract No. 13A, with the Jewett	

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Car Co., of Newark, Ohio, for car bodies	295,000.00
Contract No. 13B, with Baldwin Locomotive Works, of Philadelphia, for car trucks	61,000.00
Contract No. 13C, with Westinghouse Electric Mfg. Co., of Pittsburgh, for car motor equipments	232,600.00
Contract No. 13D, with Westinghouse Traction Brake Co., of Pittsburgh, for air brake equipment	22,500.00
Total	$871,811.04

Work has been commenced on all of these contracts, and it appears probable that all of the material will be delivered before the dates specified in the contracts for such delivery.

Specifications for the remainder of the material required and for the construction of tracks and car barn are being prepared and will be completed as needed. At the present time I see no reason why all of the work should not be completed on or before the dates mentioned above.

Terminal Loops—

The tracks on Van Ness avenue from Vallejo street to Chestnut street; on Chestnut street from Van Ness avenue to Scott street; on Scott street from Chestnut street to Greenwich street; on Greenwich street from Scott street to Steiner street; on Steiner street from Greenwich street to Union street; on Union street from Steiner street to Franklin street; on Franklin street from Union street to Vallejo street; and on Vallejo street from Franklin street to Van Ness avenue; form a double loop, differing from the terminal loop of the United Railroads at the Ferry only in its size, over which southbound cars from the Ferry or Stockton street, via Columbus avenue, or northbound cars from Geary street or south of Market street, via Van Ness avenue, can be operated past the gates of the Exposition on Chestnut street and back to their points of origin, without loss of time other than that necessary to discharge or receive passengers. The Fort Mason extension is also to be constructed with a terminal loop on Laguna street.

In other words, the arrangement of tracks of the proposed street railways will be such as to provide three single track terminal loops at the Exposition.

At the present time 263 cars per hour are operated over the two loops at the Ferry during the rush hours, notwithstanding the obstruction caused by the heavy traffic on the Embarcadero. By giving the traffic squad of the Police department proper authority and making suitable provision for loading and unloading passengers on Chestnut street, it will be possible to operate as many or more cars (130 per hour) over each single track loop as are at present operated over each of the Ferry loops. With three loops we will then be able to operate 390 or say 400 cars per hour past the gates of the Exposition.

Capacity of Tracks—

Mr. Arnold, in his report on Transportation to the Exposition (see pages 59 and 60 of the Report on Transportation Facilities of San Francisco), estimated the capacity of a double track street railway at 120 cars per hour. Since Mr. Arnold's report was written, however, the operations of the traffic squad have so facilitated the movement of the street cars on Market street that the United Railroads are at the present time averaging 180 cars per hour over these tracks during the rush hours.

Taking into account the steeper grades on Van Ness avenue and on Columbus avenue and North Point street, it appears probable that the capacity of the Van Ness avenue and Columbus avenue lines will be somewhere between Mr. Arnold's estimate and the present capacity of Market street, or say 150 cars per hour, for each route, or say 300 cars per hour for both routes.

Capacity of Cars—

The City at the present time owns 43 cars, which are in use on the Geary Street Railway. One hundred additional cars have been ordered, so that there will be available for use on the Municipal railways at the time of the Exposition, 143 cars. Assuming that 13 of these cars will be held in reserve, 130 cars will be available for the transportation of passengers.

The number of trips to the Exposition which can be made by these cars depends upon the method of routing which is adopted. The following is a method which it is believed will prove satisfactory:

From the Ferry via Columbus avenue to the Fort Mason terminal.

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From Market and Stockton streets, via Columbus avenue, to Fort Mason terminal.

From the Ferry, via Geary street and Van Ness avenue, to Chestnut street terminal.

From Thirty-third avenue and Geary street and from Thirty-third avenue and California street, via Geary street and Van Ness avenue, to Chestnut street terminal.

From Potrero avenue and Twenty-fifth street, via Van Ness avenue, to Chestnut street terminal.

From Thirtieth and Church streets, via Van Ness avenue, to Chestnut street terminal.

At the present time the cars on the Geary Street Municipal Railway are operating at an average speed of slightly less than 11 miles per hour. For the purpose of this estimate, it is assumed that cars on all of the Municipal railways can be operated at an average speed of 9 miles per hour. This will enable us to maintain a headway of 2 minutes and 20 seconds on each of the above routes. The headway on each of the three loops at the Exposition will then be 1 minute and 10 seconds. In other words, 51 cars per hour will pass over each loop or 153 cars per hour over 3 loops.

The maximum capacity of the cars at present in use on Geary street is 125 persons. The maximum capacity of the proposed new cars is 150 persons. Assuming that during rush hours cars will carry to the Exposition an average of 125 persons per car, the maximum capacity of the proposed equipment of cars to the Exposition will be 19,125 persons per hour.

Summarizing the above statement, the capacity of the terminal loops at the Exposition is 400 cars per hour or 50,000 persons per hour. The capacity of the tracks of the proposed Municipal Street Railways to the Exposition is 300 cars per hour or 37,500 persons per hour. The capacity of the cars contemplated is 153 cars per hour, or 19,125 persons per hour.

In other words, the capacity of the terminal loops and tracks of the proposed street railways is far in excess of the number of cars which it is probable the City will own at the time of the Exposition.

Adding to 19,125 (the maximum number of persons transported by the Municipal Railways) 12,000 (the maximum number of persons transported by private lines), we have 31,125 persons per hour as the maximum number which can be transported to and from the Exposition by municipal and private lines combined.

It is to be noted that the above estimates contemplate operating cars in a crowded condition. They should be reduced by 20% or to 24,100, to arrive at the comfortable carrying capacity of the cars. It is also to be noted that to secure this maximum carrying capacity it will be necessary to abandon through service on Geary street.

From estimates as to the probable attendance at the Exposition, it appears probable that on days of average attendance at the Exposition it will be necessary to provide transportation for from 20,000 to 25,000 persons per hour and that on special days when the attendance at the Exposition is greatest, it may be necessary to transport as many as 62,500 persons per hour.

Bearing in mind the fact that through traffic on Geary street cannot be abandoned except on special days without causing unreasonable inconvenience to the public, it appears probable that the transportation which can be furnished to and from the Exposition by means of the Municipal Street Railways in conjunction with privately owned street railways, will, even on days of ordinary attendance, necessitate the public enduring the discomfort of riding in overcrowded cars during the periods of heavy travel. It is also apparent that on days of maximum attendance, the transportation furnished will not be sufficient to meet the demand.

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Engineer's Note Book

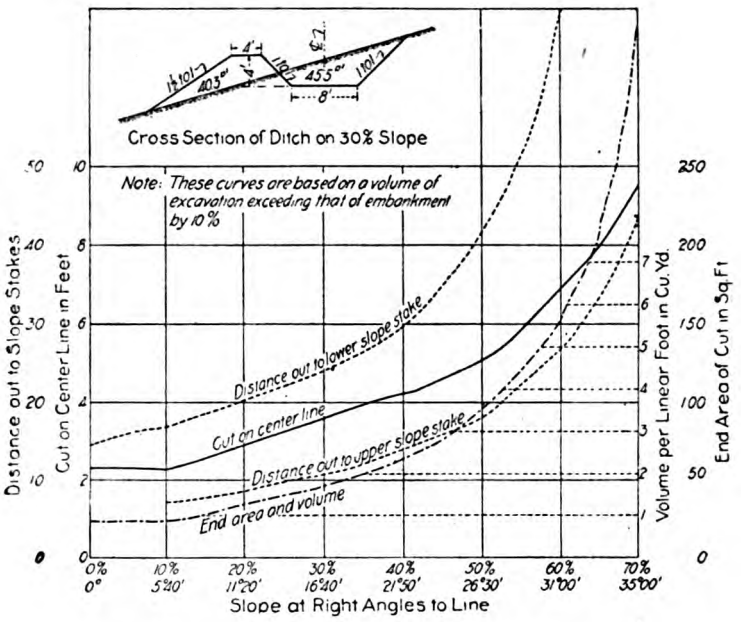
Method of Figuring Excavation

By M. R. LEWIS

The method of figuring excavation described below is useful for small and medium-sized irrigation canals and for the poorer classes of highways, as in the case of a maximum grade sustained for a considerable distance.

In this class of work it is desirable to have the cut at each point exactly balance the fill at that point so that the earth does not have to be hauled along the line at all. It can then be handled economically by a road machine, a pick-and-shovel crew, or a steam shovel, without wagons or cars. In a rough country where most of the work is done along side hills of varying slopes it is impossible to run a transit line to fulfil this condition with a reasonable expenditure of time, hence some method of fudging the line is necessary.

To accomplish this rapidly in the field I have found the following method convenient and reasonably accurate: After the cross-section of the finished work has been decided on, a curve is plotted having the slope across the line (expressed either as per cent or degrees) as abscissae and the proper cut on the centre line of the ditch or road to produce the equality of cut and fill as ordinates. This is then taken into the field and a transit line run to give approximately the cut shown for the varying slopes. Levels are run over the transit line in the usual way, taking the elevation of the station or half-station stakes and at prominent breaks in the profile, where extra stakes should be set. When the line is cross-sectioned the levelman determines the slope at the station either by direct observation with some simple form of clinometer or by reading the rod at the station and again at some distance, such as 10 ft., either to the right or to the left. By inspection of the curve the proper cut on the centre line is then found and the centre-line stake set to make it, and the rest of the cross-section is taken and the slope stakes are set in the usual way.



CURVES FOR BALANCING EARTHWORK QUANTITIES.

Of course, in plotting the curve an allowance must be made for the settlement of the embankment. In the case of an irrigation canal having an 8-ft. bottom width, 1:1 slopes on the inside and a 1½:1 slope on the outside of the bank, an allowance of 10%

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was found insufficient in loose-gravel soil, due chiefly to the fact that the loose rocks rolled out beyond the theoretical toe of the slope.

When the curve is plotted another curve may be plotted showing the end areas of the sections and also the volume of the excavation per unit length, which is very useful in making up preliminary estimates. Curves showing the distance out to the upper and lower slope stakes are also useful in estimating the amount of clearing and grubbing necessary, as well as to the man doing the cross-sectioning, as changes in the slope within the limits of the section may have an important bearing on the proper position of the centre line.

The curves shown are for a ditch described on the preceding page, a cross-section of which on a slope of 30% is shown.—*Engineering Record.*

Hydraulic Constants

WEIGHT, VOLUME, AND PRESSURE OF WATER

1 cu. in.	=	0.03608 lb.
1 cu. ft.	=	62.355 lb.
1 cu. ft.	=	7.481 U. S. gal.
1 U. S. gal.	=	231.0 cu. in.
1 U. S. gal.	=	8.34 lb.
1 U. S. gal.	=	0.1337 cu. ft.
1 lb.	=	0.016037 cu. ft.
1 lb.	=	27.712 cu. in.
1 lb.	=	0.1199 U. S. gal.
100 ft. head of water	=	43.31 lb. per sq. in.
100 lb. per sq. in.	=	230.9 ft. head.

VALUE OF 1 ATMOSPHERE OF PRESSURE

Lb. per sq. in.	14.7
Ft. head of water	33.947
In. of mercury	30.0

Temperature 62°F.

Pneumatic Constants

WEIGHT AND VOLUME OF AIR

1 cu. ft. = 0.076097 lb. = 1.217 oz.

1 lb. = 13.141 cu. ft.

VALUE OF 1 ATMOSPHERE OF PRESSURE

Lb. per sq. in.	14.7
Column of water, ft.	33.947
Column of mercury, in.	30.0

PRESSURE EQUIVALENTS

1 lb. per sq. in. = 2.04 in. of mercury = 2.309 ft. of water.

1 in. of mercury = 0.49 lb. per sq. in. = 1.132 ft. of water.

1 ft. of water = 0.433 lb. per sq. in. = 0.883 in. of mercury.

Temperature 62°F.; pressure 14.7 lb. per square inch.

Hints on Practice

Pump-Valve Leakage

Pump ailments have been set down as short stroking, leaky piston-rod packing, leaky steam valves and piston, air leaks in the suction pipe, and other minor troubles.

The accepted standard of piston speed for a boiler-feed pump is not more than 100 ft. per minute. However, a lesser piston speed is advisable. If the piston packing leaks so that the water surges from one end of the cylinder to the other, the piston speed of the pump must be increased to get the desired volume of water. If the piston packing is tight and no leakage occurs past the piston, but the water valves and valve seats are worn (and all valve seats do wear), there will be excessive leakage of water past the valves, which reduces the capacity of the pump over what it should be when running at the same speed and in good condition.

For instance, if a pump has a 6-in. water cylinder and a 10-in. stroke, it will pump a maximum of 257 gal. of water per minute at a speed of 54 revolutions per minute. Suppose that the suction and discharge valve seats of the water end of the pump are worn—and most of them are after being used a while—the water from the source of supply enters the pump cylinder after passing up through the suction or intake valves. The tops of the intake valves are subject to the discharge pressure in the pump, which lifts the discharge valves from their seats.

While one end A of the pump cylinder is discharging, the valve B is closed and the valve C is open. On the other end of the cylinder the position of the valves is reversed, and the valve D is open, admitting water to the end F of the cylinder, but the valve E is closed.

If the valves and seats are worn, water discharging from the end A of the cylinder will pass up through the discharge valve C, but some of the discharge water will be forced between the suction valve B and its seat into the intake passage and then down into the suction pipe, or up through the

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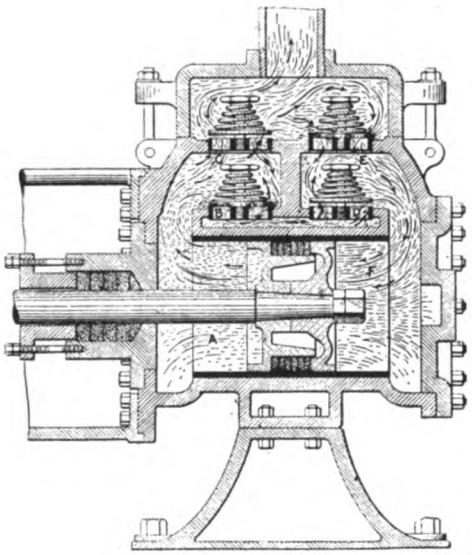
valve D and into the end F of the cylinder. What water goes toward the suction pipe counteracts the upward movement of the water, due to the partial vacuum formed in the end F of the pump cylinder. The amount of water entering the end F from the end A reduces the capacity of the pump just that much.

On the same stroke water under pressure is being forced back between the valve E and its seat into the end F of the cylinder, which further reduces the capacity of the pump.

This is a condition present in most



PUMP VALVE LEAKAGE.

pumps to a greater or less degree, generally greater, because the engineers do not give the valve seats proper attention. There is no gain shown by skimping on the coal pile, working overtime packing leaky pipe flanges and valve stems, if the steam pumps are allowed to run in such a condition that they are consuming a great deal more steam than they should.

For instance, in one plant there were two compound simplex pumps operating at 25 revolutions per minute. One used 1000 lb. of steam per hour, the other pump nearly double the quantity, or 1800 lb., in doing the same work. The trouble was that the valves and valve seats on the wasteful pump were worn out of true.

One would suppose that the engineer of that plant would have suspected something was wrong with the wasteful pump; but not so. He was much like the engineer of another large plant. This man was a progressive, intelligent, up-to-date engineer, who claimed he had never had any trouble with his pumps.

Something like a year ago a new heating system was put in and guaranteed to make a large saving in fuel, but the system did not come up to expectation. An investigation showed that the circulating pump was wasting a large amount of steam. The water-valve seats of the pump were refaced, and the service was so improved that in half an hour after the pump was started the necessary amount of water had been supplied and the pump was stopped. The pump was working against 500 lb. pressure.

It is the procedure in several shops where pumps are manufactured to force the valve seats into place in new pumps. This may cause portions of the seat to bulge, making as many high spots on the valve face as there are bars. If bulging occurs it is just as necessary to reface the valve seats as if they were badly worn, which can easily be accomplished by a pump-valve reseating machine made for the purpose, and which can be used without dismantling the pump.

Another instance can be cited where worn pump valves necessitated running two pumps, when one in proper condition could have supplied all of the water required. These pumps were each supplied with steam through a ¾-in. steam pipe. They were run about 75 strokes per minute to supply the required water. The manager finally decided to have the pump-valve seats faced true. After one hour's work one pump was running at 18 strokes per minute, supplying all the water necessary, the other pump being idle.

In another instance a pump had been in use for 11 years. It had been condemned, and a new one was to take its place. However, before it was discarded, the valve seats were machined and the pump put in serviceable condition, good for another 11 years' work, and, furthermore, saving in the neighborhood of $350 in the cost of a new pump.

As a last instance of many which could be cited, a pump fed by a 1½-in. steam line was run at a speed capable of supplying 615 boiler horse-power with feed water. After putting the valve seats in proper shape the

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speed of the pump was cut down about 65%, and is doing good work today.

Most engineers are willing to believe the worst that can be said about a neighboring plant, but cannot, or will not, see the shortcomings of their own. They can tell you all about the engine, its steam consumption, and other data about the plant, but on the subject of the steam pump, while admitting that they are steam eaters, they are silent. They do not know the actual condition of their pumps, for one thing, and because the pumps have been in use for years and have been able to keep the boilers supplied with feed water, it is assumed that the internal parts are in good shape, and further consideration of their economical operation is neglected. The pumps, therefore, are run at a faster speed than they should to supply the necessary water, and the owner pays the excess fuel bill because of excessive steam consumption.—*Power.*

Industrial Progress

Motor-Driven Irrigation Outfits

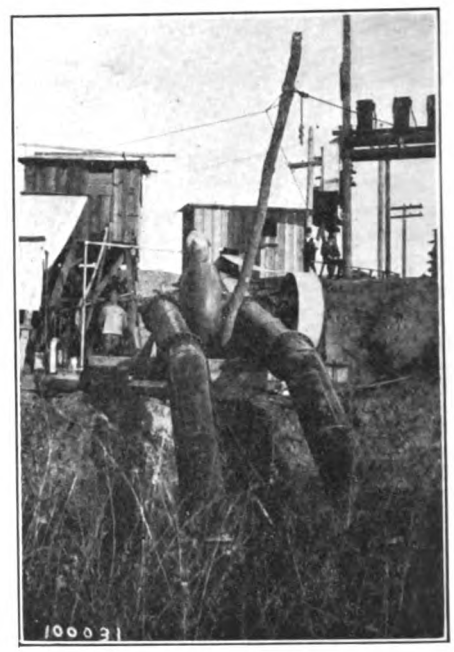
In view of the interest being taken by the electric power companies in developing the irrigation fields as a means of selling current, the following examples of motor driven irrigation outfits installed on the Pacific coast will undoubtedly prove interesting:

At the irrigation plant of the Moulton Irrigated Land Co., near Princeton, Butte county, Cal., a 30-in. Byron-Jackson centrifugal pump driven by a 150-hp. Westinghouse induction motor has been installed. This unit is designed to deliver 30,000 gallons at a head of 18 ft., but, due to the rise and fall of the river, the working head varies, and when the river is unusually high, the motor is considerably overloaded.

This condition obtained last spring, and for a period of several days the motor operated continuously at about 225 hp., or 50% overload. In spite of these very severe conditions, the motor kept steadily at work, irrigating about 1500 acres of beans, barley, and wheat. If the motor had failed at this particular time, the crop would have been lost.

Power for the motor is derived from the 60,000-volt lines of the Pacific Gas & Electric Co. The voltage is stepped down to 11,000 for transmitting 18 miles, and is then stepped down to 440 for the motor. The cost for installing the irrigating system has not exceeded $15 per acre, while the value of the land has increased $50 to $75 per acre. The cost of irrigation per acre does not exceed $1.25 including labor.

In order to irrigate its rice fields along the Sacramento river, the Moulton Irrigated



DIRECT ELECTRICALLY DRIVEN IRRIGATION PUMP.

Land Co., Butte county, Cal., has adopted the somewhat unique plan of installing a motor-driven pump on a barge, which is towed from point to point by a gasoline launch and is thus able to accomplish what would otherwise require four stationary plants. The barge contains a 20-in. Dow centrifugal pump belted to a 100-hp. Westinghouse induction motor. Power is obtained at the four pumping points from 11,000-volt lines of the Pacific Gas & Electric Co. A bank of transformers on the barge transform this current to 440 volts for use by the motor.

The pump handles about 16,000 gallons per minute. The head varies from 12 to 23 ft. as the river rises and falls, and the motor is overloaded about 30% during the period of low water.

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Book Reviews

GRAPHICS AND STRUCTURAL DESIGN. By H. D. Hess. John Wiley & Sons, New York. P. 415. Index. For Sale by *Mining and Scientific Press*, San Francisco. Price $3.

Graphics is said to have been invented by a man who was too lazy to figure. Although this saying is probably apocryphal, it would seem nevertheless that the inventor, whoever he may have been, is entitled to a monument in the engineering hall of fame for the benefits he has conferred upon succeeding generations. Now-a-days the use of graphics has overturned the bounds of engineering and has invaded commercial life. Curves, diagrams, and even 'stress sheets', as it were, may be found to play a prominent part in the presentation of problems dealing with economics and commercial reports that were formerly the special field of the actuary and the accountant. As a means for the determination of stresses in structural design, it has come to be almost universally employed, especially in checking the accuracy of mathematical calculations. Although the word 'Graphics' is used in the title, mathematical determinations are also covered in the subject matter. A summary of the chapter titles is as follows: Materials; Graphics; Stresses in Structure; Algebraic Determination of Stresses; Influence Diagrams; Tension Pieces; Compression Pieces and Beams; Columns; Girders for Conveyors; Trusses; Bents and Towers; Design of Steel Mill Buildings; Design of a Plate Girder Railway Bridge; Crane Frames; Girder for Overhead Electric Traveling Cranes; Reinforced Concrete Foundations; Chimneys; Retaining Walls; Bins; Shop Floors; Walls and Roofs; Specifications and Problems.

CONCRETE ROADS AND PAVEMENTS. By E. S. Hanson. The Cement Era Publishing Co., Chicago. P. 227. Index. For Sale by *Mining and Scientific Press*, San Francisco. Price $1.

Concrete as a type of material for road construction has recently come into surprising prominence. In fact this prominence has been achieved so rapidly that information as to the behavior of concrete under present day traffic conditions has hardly kept pace with the rapidity with which it has been adopted. Practically all of the various data that have been made public on this subject has appeared in the columns of the technical press and Mr. Hanson, who is editor of the *Cement Era*, has done an excellent work in compiling the various data in systematic form for the service of road engineers and others interested. The quantity of detailed cost data presented is easily a feature of the book and no less valuable are the specifications used and results obtained in various localities. The general subject is sub-divided into chapters covering Concrete as a Road Material; The Construction of Concrete Roadways; The Roads of Wayne County, Michigan; Cost of Concrete Roads in Illinois; Other Examples of Concrete Roads; Some Data on City Pavements; Reinforced Concrete Pavements; Concrete in Combination with Other Materials; Patented Concrete Pavements; The Theory and Practice of Joints; Some Tests on Concrete as a Roadway Material; Bridges and Culverts; Sidewalks, Curbs, and Gutters; and an appendix on various specifications.

BULLETIN NO. 66. MINING LAWS OF THE UNITED STATES AND CALIFORNIA. California State Mining Bureau, San Francisco. F. McN. Hamilton, State Mineralogist.

In preparing this publication for general distribution, the State Mining Bureau has done a work that will be appreciated by all mining men and others interested in any phase of development work pertaining to public lands. The federal and state statutes are given, as well as the corporation license tax and various enactments of the State Legislature with reference to natural gas and protection of oil and gas strata. The so-called 'blue sky law' and the water commission act, both of which pertain to mining operations, are given in an appendix.

THE 'MECHANICAL WORLD' ELECTRICAL POCKET BOOK FOR 1914. Published by Emmott & Co. Ltd., Manchester, England. Pages 240. Index. For sale by the *Mining and Scientific Press*, San Francisco. Price $1.

The new edition includes additional data on telephones, the electrical equipment of ships, lifting magnets, dry batteries, sparking distances in air, and burglar alarms. Sections on electricity in coal mines, transmission conductors and cables, accumulators, motor starters, electrical measuring instruments, electric bells, electric lamps, and electric lighting have been revised and expanded.

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Company Reports

The California Railroad Commission has rendered a decision granting authority to the San Diego Consolidated Gas & Electric Co. to issue $41,000 of bonds. Certificates of public convenience and necessity were issued today by the California Railroad Commission to the Fresno Traction Co., granting authority to extend its line 9½ miles along the San Joaquin river and to construct crossings at grade to the Wilmington Water Co., giving the right to do business in Los Angeles county, and to E. M. Wilson, Nettie B. Harris, and L. A. Wilson to operate an electric light plant in Bieber and Lookout, Modoc county.

The California Railroad Commission has granted a certificate of public convenience and necessity to the California Power & Manufacturing Co. to sell power in the territory which can be served from the existing plant of Florin Brothers at Fall River Mills. The Commission directs that the applicant shall, in good faith, begin as soon as possible the development of power at Fall River site, and shall, by October 1, 1914, have in readiness to deliver to consumers all the power that may be developed at this plant.

The Southern California Edison Co. has reported for 1913 as follows:

Gross earnings	$4,779,280
Net earnings	2,354,465
Interest and amortization	818,850
Depreciation	700,000
Preferred dividends	200,000
Common dividends	420,000
Surplus	215,615

The United Light, Fuel & Power Co. of San Diego, has filed an amended application for authority to issue $198,000 stock to be used for the purpose of liquidating indebtedness and to provide for extending its system.

The San Francisco-Oakland Terminal Railways has applied to the California Railroad Commission for authority to issue $1,000,000 bonds as additional security for the $2,500,000 notes which have been extended by the holders. Permission is also asked to issue $500,000 collateral trust 7% notes. The proceeds will be applied to the east bay system.

The Standard Oil Co. of California has issued the following balance sheet for the year ended December 31, 1913:

ASSETS.

Plant investment	$50,268,456.52
Other investments	190,750.00
Inventories	21,724,390.37
Accounts receivable	6,083,042.95
Unexpired insurance, taxes, etc.	164,189.06
Cash	1,065,266.06
Producing properties, valuation	8,474,659.33
Total assets	$87,970,754.29

LIABILITIES.

Capital stock authorized	$50,000,000.00
Less treasury stock	4,816,006.33
Capital stock issued	$45,183,993.67
Accounts payable	7,448,017.21
Capital stock premium account	250,000.00
Surplus (invested as above)	35,088,743.41
Total liabilities	$87,970,754.29
Net earnings for 1913	$19,386,140.46
Dividends paid during year	4,493,399.40
Balance carried to surplus	$14,892,741.06

The General Petroleum Co. reports that $7,620,600 bonds have been deposited with the Mercantile Trust Co., and $300,000 in New York, making a total of $7,920,600. With the $1,500,000 notes that have been pledged for exchange, the company is now assured of more than the $9,000,000 bonds required to make the deal with the Western Ocean Syndicate fully effective. This gives the company a call on $3,000,000 cash, about half of which has already been furnished. Of the stock, 265,516 shares have been deposited, leaving less than 100,000 shares outstanding.

The Pacific Light & Power Corporation has filed an amended application with the California Railroad Commission asking for authority to issue $1,730,000 bonds. It proposes to use $497,000 of these bonds for making sinking fund payments. The balance is desired to refund indebtedness.

The Pit River Power Co. has applied for a certificate of public convenience and necessity to supply electricity in the northeast portion of Shasta county, in Modoc county and in Lassen county.

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Engineering News

Petroleum

California oil dividends for January were as follows:

Company.	Rate.	Amount.
Amalgamated	$1.25	$62,500.00
Amer. Petroleum, pfd.	0.005	8,755.50
" common	0.001-3	39,607.00
Columbia	0.015	51,283.65
Coalinga, Mohawk	0.02	10,000.00
Caribou	0.02	16,140.00
Fullerton	0.20	120,000.00
Kern River	0.10	10,000.00
Olinda Land	0.0025	10,000.00
Pinal-Dome	0.0025	10,000.00
Producers' Trans. Co.	0.015	105,000.00
Peerless	0.25	25,000.00
Rice Ranch	0.01	3,000.00
San Fran. & McKittrick	0.20	10,000.00
Section Twenty-five	0.25	10,000.00
West Coast, pfd.	1.50	15,612.00
Western Union	0.01	10,000.00
Total		$521,898.15

CALIFORNIA FIELD OPERATIONS AND PRODUCTION FOR MONTH OF DECEMBER, 1913

Field.	Rigs completed during month.	Wells: Drilling.	Wells: Completed during month.	Wells: Abandoned during month.	Wells: Producing.	Production for month.
Kern River	..	4	..	..	1181	642,017
McKittrick	..	1	..	..	259	318,065
Midway and Sunset	12	114	20	4	1252	3,810,042
Lost Hills-Belridge	1	20	3	..	210	463,330
Coalinga	..	31	3	1	853	1,398,093
Lompoc-Santa Maria	1	8	2	..	241	389,341
Ventura County-Newhall	4	29	1	..	411	79,378
Los Angeles-Salt Lake	1	4	2	8	698	224,668
Whittier-Fullerton	2	56	1	..	504	1,161,554
Summerland	..	..	..	..	125	4,950
Total	21	267	32	13	5734	8,491,438

San Francisco, Cal.—It is reported that the Mays Consolidated Oil Co., consisting of about 500 acres on sections 28 and 30 in the Midway field, has ben sold to Louis Titus of the North American Oilfields Company. ——The Standard Oil Co. has announced that the minimum price to be paid for crude petroleum ranging from 14 to 20.9°B. will be 40c. per barrel until further notice. This price applies to the production of the Kern River field, and also to a large portion of the production of the Midway-Sunset district and the Coalinga field. This is an advance of 5c. per barrel over the previous prevailing price.——The Fullerton Great Western Oil Co. has been organized by A. J. Bradley, E. A. Stopher, J. D. Mollison, and G. A. Fish, of San Diego. This company has secured a lease of a portion of the Tuffie ranch in the Fullerton field. The property comprises 40 acres and is situated near the holdings of the Walker-Brand, Union, Standard, and Monte Cristo companies.——W. R. Kennedy, manager of transportation for the General Petroleum Co., has stated that before the end of the year the company will have in operation ten tank steamers of 60,000 bbl. each, some of which will be equipped with Diesel engines.——The Pitt Oil Co. of Pittsburgh, Pennsylvania, has secured a lease on about 70 acres of the Weston ranch near Redondo, and drilling operations are to be started as soon as possible. J. H. Short, O. A. Mardorf, and I. D. Warrington, of Pittsburgh, are interested. ——It has been announced that the Mascot Oil Co. will return to a dividend paying basis on February 25 at the rate of 0.6 of 1% per month.——The Fullerton Oil Co. has just declared a dividend amounting to $120,000 or 20% on its capitalization of $600,000. The regular dividend is 5% quarterly. The addition of $90,000 represents an extra dividend of 15%, declared for the purpose of distributing the surplus which has

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accumulated in the company's treasury.——The sales of the Independent Producers' Agency during the month of December amounted to 1,200,000 bbl. at an average price of 36½c. per barrel.——L. P. St. Clair, president of the Producers' Transportation Co., a subsidiary of the Union Oil Co., has recommended that $500,000 be expended for the construction of a pipe-line from Junction to the McKittrick and Taft districts.——Shipments of pipe for the Standard Oil Co.'s fourth pipe-line over the Kern River and Mendota fields are arriving along the route. It is expected that this line will be completed before the end of July. This company has ordered 800 tons of steel plate for tank construction on the Blume ranch. A 72,000-bbl. tank, said to be the largest tank on the Pacific coast, is being erected at the Richmond refinery of the Standard Oil Co.——The Indian & Colonial Development Co., operating in the Midway field near Taft, California, is making plans for the installation of a compressor plant at a cost of $10,000. The plant is to have a capacity of 750 cu. ft. of free air per minute, and will be steam driven.——The Producers' Transportation Co. is arranging to double its pipe-lines from Olig station, north of McKittrick, to Junction, a distance of 30 miles.——The United States District Court has rendered a decision that provides a working plan for the continuation of oil production on the lands in dispute under the Government Withdrawal Act of 1909. The proceeds from the sale of oil are to be impounded until the suit has been decided. G. W. Helm, chief of the field division of southern California, has been appointed commissioner to receive money from the sale of oil on contracts made with his approval.——The work of grading the sites for the 20 steel tanks for the oil tank farm under construction for the Royal Dutch-Shell Co. in the Coalinga field is finished and several carloads of steel plates have been delivered on the ground. The Pinal Dome Oil Co., operating in the Santa Maria field, has placed an order for Laidlaw-Dunn-Gordon compressors with a capacity of 2,500,000 cu. ft. of gas per day for the manufacture of gasoline from casing-head gas.

Streets and Roads

San Francisco, Cal.—The Board of Supervisors is considering repaving Third street.

Napa, Cal.—The Board of Supervisors has decided to call a bond election to provide $150,000 for the construction of roads and bridges in this county.

Sacramento, Cal.—The following contracts for portions of the California state highway were let on February 4:

San Luis Obispo county—Santa Margarita to Atascadero, 8.4 miles, to George S. Benson & Sons, of Los Angeles; bid, $34,784.25; materials furnished by state, $38,551.35; total, $73,335.60. Paso Robles to north county line, 10.6 miles, to W. A. Dontanville, of Pasadena; bid, $46,297.20; materials furnished by state, $46,084.15; total, $107,381.35.

Kern county—Lerdo to Famoso, 8.9 miles, to George S. Benson & Sons, of Los Angeles; bid, $24,127; materials furnished by state, $34,597.50; total, $58,724.50. Bakersfield to Lerdo, 10.1 miles, to George S. Benson & Sons, of Los Angeles; bid, $32,161; materials furnished by state, $41,895; total, $74,020.

Santa Cruz county—Easterly boundary to Glenwood, 5.7 miles, to Warren S. Foss, of Berkeley; bid, $54,985; materials furnished by state, $6,224.20; total, $61,209.20.

Ventura county—Ventura to Sea Cliff, 7.7 miles, to Carl Leonardt, of Los Angeles; bid, $81,544.25; materials furnished by state, $30,060.28; total, $111,604.53.

San Bernardino county—Westerly boundary to Upland, 1.7 miles, to Lewis Ferrell, of Pomona; bid, $12,707.98; materials furnished by state, $4,656.07; total, $17,364.05.

El Dorado—El Dorado to Placerville, to Arthur S. Lyon, of Smith's Flat; bid, $56,411; materials furnished by state, $10,395.95; total, $66,806.95.

Colusa, Cal.—A bond election has been called to provide a total of $452,000 to provide funds for road building, bridges, and culverts.

Salt Lake City, Utah.—At a hearing before the City Commission, Sylvester Q. Cannon, city engineer, reported that the result of paving with Utah rock asphalt has been unsatisfactory and that in his opinion California refined asphalt should be used for street work in the future. Nine streets are to be improved for 1914. The cost of the city's share alone will be $65,187.

Ogden, Utah.—Approximately 18 city blocks and avenues are to be paved during the coming season. Twenty-fifth street between Wall and Washington avenues will be repaved early in the spring. Chris Flygare

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is superintendent of streets.——The Ogden Canyon highway is to be repaired and improved. Ralph S. Corlew is county road supervisor.

Spokane, Wash.—The Attorney-General has decided that $31,799 not hitherto counted as available may be used for constructing a portion of the Inland Empire highway.——Petitions have been filed for paving an arterial highway between Spokane and Hillyard via Illinois avenue and Fisk street. The petition has been referred to the city engineer.——Baldwin avenue from Dakota to Hamilton street and Dakota street from Indian avenue to Baldwin, and Indian avenue from Division street to Hamilton street are to be repaved.

Wenatchee, Wash.—The Council is considering the improvement of a number of streets, and improvements will consist of graded and graveled streets, concrete sidewalks, and new water mains.

Walla Walla, Wash.—The County Commissioners have voted to improve five additional miles of the Inland Empire highway for which bids will be called for immediately.

Ritzville, Wash.—The City Council is taking steps toward the regrading and graveling of East street for a distance of about 1¼ miles.

North Yakima, Wash.—Five blocks of the extension of North First street is to be repaved.

Omak, Wash.—The County Commissioners have allowed the petition for the formation of improvement district No. 5. Four miles of macadam road is to be built.

Davenport, Wash.—A total of $60,000 is to be spent for road improvements and maintenance within the three road districts of this county.

Moscow, Idaho.—Five miles of new paving is to be done in Moscow in 1914. Last year more than 75,000 yards of Dolarway pavement were laid in Moscow.——A new paving district is to be formed on North Main street beyond the Idaho National Harvester plant and which is to be more than one-half mile long.

Wallace, Idaho.—The City Council has under discussion the paving program for 1914. Estimated cost of materials were as follows: Concrete, $5980; Hassamite, $6690; Hassam, $6290; Dalarway, $6290; granitoid, $6600; standard bitulithic, $7500; wood block, $9180; bitu-mass, $6600; bitulithic resurfacing, $6160.

Railways

San Francisco, Cal.—The Southern Pacific Co. has filed application with the Railroad Commission for permission to issue bonds in the sum of $55,000,000 for the purpose of extensions and improvements on their system. Of the total amount, nearly one-half of the proceeds will be expended for betterments in California and the remainder will be used on the company's properties in Oregon, and on the Sunset line in the Southwest. Construction work on the Fernley and Lassen branch is to be completed. Extensions are to be made for the Alameda county suburban system and various other improvements are to be carried out.——The Board of Works has placed a contract with McNab & Smith for hauling ties for the municipal railway extension at 2½c. per tie. Bids are called for electric wiring, vacuum cleaning, and pneumatic tube system for the new city hall at an estimated cost of $90,000 and for a water supply system at an estimated cost of $12,000.——The San Diego & Arizona Railway Co. is granted permission to issue $10,000,000 in bonds and $3,000,000 in stock for the purpose of completing its line from San Diego into the Imperial valley. The line will be approximately 140 miles long. J. D. and A. B. Spreckels, of San Francisco and San Diego, are the largest stockholders.

Santa Rosa, Cal.—A survey has been started for a new electric car line to run from Graton to Camp Meeker in connection with the present Petaluma and Santa Rosa electric railway. It will be 7 miles long and will cost $20,000. J. H. Brush, of Santa Rosa, M. C. Meeker, of Camp Meeker, and George P. McNear are back of the project.

Olympia, Wash.—The Richland Northern Railway Co. has been organized with a capital stock of $1,000,000 to build a line from Richland, Benton county, northerly to a connection with the Chicago, Milwaukee & St. Paul railroad. Manley F. Haynes, F. J. O'Brien, and B. F. Knapp are the incorporators, all of Seattle.

Tacoma, Wash.—The City Council has passed an ordinance authorizing a bond issue of $75,000 for the construction and equipment of a municipal street car line which will be about one mile long.

North Yakima, Wash.—The Yakima Valley Transportation Co., which operates 20 miles of city and suburban lines in this

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vicinity, has completed a survey for the extension of its Wide Hollow line about 10 miles into the Tieton unit of the Yakima reclamation project. N. C. Richards is president of the company.

Carson, Nev.—It is stated that the Excelsior Mountain Copper Co., Frank B. Qualey, general manager, will install a small railroad to facilitate the transportation of its ores from the mines to the smelter at Wabuska. The mines are situated at Lone Mountain, Mineral county.

Washington, D. C.—The Alaska railway bill appropriating $40,000,000 for the construction of a railroad 1000 miles long in Alaska has passed the Senate.

Miscellaneous Engineering Construction

San Francisco, Cal.—The Board of State Harbor Commissioners has awarded a contract for the construction of pier 46 at the foot of Channel street to the Healy-Tibbetts Construction Co. for the sum of $146,215. The pier will be 200 ft. wide, 800 ft. long, and constructed of creosoted piling. Pier No. 26 recently constructed of reinforced concrete at a cost of $517,650 has been assigned jointly to Balfour Guthrie & Co. and W. R. Grace & Co. Bids are called for for additions to pier No. 54 and an additional ferry slip.——The tax collector has commenced a computation of the assessment for the Twin Peaks tunnel construction; 16,139 parcels of land are affected and the cost of the tunnel will be approximately $4,000,000.——The Superior Court has upheld the validity of the San Francisco harbor bonds, thus releasing $4,675,000 for immediate improvements.——The West Sacramento Co., Byron D. Kilgour, sales manager, with offices in the Alaska Commercial building, will expend $1,000,000 in the construction of concrete docks on the Sacramento river. ——A contract has been placed by the U. S. army board of engineers with Standard American Dredging Co. for blasting Centissima rock at a cost of $61,000.

Oakland, Cal.—A contract has been placed with the San Francisco Bridge Co. for a bulkhead 4000 ft. long for that portion of Brooklyn basin lying between 9th and 19th avenues.

Sacramento, Cal.—Plans have been ordered for a reinforced concrete municipal wharf to be situated on the site of the Canneries wharf between O and P streets. The estimated cost will be $9000. Albert Givan is city engineer.

Red Bluff, Cal.—The Board of Supervisors has ordered the preparation of plans and specifications for a steel bridge on the Red Bluff and Susanville route. E. C. Luning is city engineer.

Salt Lake City, Utah.—The bid of Ryberg Bros. for building the Ninth South street storm sewer will probably be accepted. Their bid varies from $15,000 to $29,000, depending upon the type of construction adopted.

Grants Pass, Ore.—A contract has been awarded by the County Commissioners to Albert Anderson & Co. for constructing a reinforced concrete bridge over Williams creek at Provolt for the sum of $4680. The bridge will be 80-ft. span with a 15-ft. driveway.

Spokane, Wash.—The Washington Water Power Co. has donated a site for the construction of another bridge across the Spokane river. The new bridge will cost approximately $3400.

Davenport, Wash.—Twelve steel county bridges of various sizes are to be built in 1914. Contracts for the first two, one 60-ft. span and the other 70-ft. span, have been placed with Coast Bridge Co. of Portland, Oregon.

Wenatchee, Wash.—The County Commissioners have decided to erect a concrete bridge over the Wenatchee river at a cost of $45,000. A concrete bridge is also to be built at Dryden instead of a steel bridge as had originally been contemplated.

Twin Falls, Idaho.—It is proposed to build a bridge across the Snake river at Shoshone falls. The bridge is to be 400 ft. long, 16 ft. wide, and 20 ft. above the river. The estimated cost will be $30,000, of which Lincoln county has appropriated $10,000, the state $10,000, and Twin Falls county $10,000.

Lewiston, Idaho.—Final action is to be taken in April with regard to the joint construction of two steel bridges, one 58-ft. span and the other with two 85-ft. spans.

Butte, Mont.—It is stated that the Two Miracle Concrete Co. of Kalispell, John Tripp superintendent, has paving contracts for 1914 amounting to $150,000.

Washington, D. C.—The Senate has passed a bill authorizing the Secretary of the Navy

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to contract with the Union Iron Works of San Francisco for a temporary dry-dock at Hunters Point. The government agrees to pay not less than $50,000 per year for six years to the Union Iron Works for dockage charges for naval vessels, and the Union Iron Works in turn agrees to construct a dry-dock that will take the largest naval vessels that can pass the Panama canal.——The Rivers and Harbors Committee has recommended an appropriation of $200,000 for the Sacramento river flood-control project. The Rivers and Harbors appropriation bill carries the following appropriations for western localities:

California—Humboldt harbor and bay, jetty channel at entrance, $525,000.

Oregon—Coos bay and harbor, $50,000; Nehalem bay, $116,175; Coquille, $90,000; Columbia river between the foot of The Dalles rapids and the head of Celilo falls, Oregon and Washington, $525,000; Columbia and lower Willamette river below Portland, $300,000; mouth of Columbia river, Oregon and Washington, $1,000,000.

Washington — Columbia river between Bridgeport and Kettle Falls, $25,000; Puget sound and tributaries, $25,000; Grays harbor between Aberdeen and Chehalis river, $30,000.

Colorado river, $25,000.

Hawaii—Honolulu harbor, $120,000; Hilo harbor, $100,000.

Examinations, surveys, and contingencies fund, $25,000.

Panama, C. Z.—At a meeting of the directors of the Panama Railroad Co., the construction of an additional pier in the dock system at the Cristobal terminal was authorized at a cost of $1,100,000.

Power, Gas, and Electricity

San Francisco, Cal.—The following notices of intention to appropriate water for power purposes have been received by the State Water Commission: C. O. Poole, representing the Southern Sierra Power Co., to appropriate 300 sec. ft. on Baker creek in Inyo county; estimated cost of project, $550,000; also to appropriate 300 sec. ft. on Big Pine creek in Inyo county, estimated cost of project $1,300,000. Pit River Power Co. to appropriate 150 sec. ft. on Burney creek in Shasta county; estimated cost, $75,000. A. J. Polk, J. H. Rose, and W. H. Johns, of Coronado, to appropriate water on Carisso stream in San Diego county; notice submitted under new water commission bill held up by referendum proceedings; notified to submit amended notice. C. H. McKendree to appropriate 1500 sec. ft. on Fall river in Shasta county; cost not stated. P. L. Poyzer, of Alameda, to appropriate 15,000 in. on the North Yuba river in Sierra county; also to appropriate 20,000 inches on the same stream; cost not specified. John Bunting to appropriate 75 sec. ft. on the south fork of the middle fork of the Yuba river in Nevada county; estimated cost of project, $30,000.——The directors of the Northern California Power Co. have adopted a resolution approving the consolidation of the Northern California Co. with the Oro Electric Corporation. It is understood that a new corporation is to be organized with an authorized capital stock of $12,500,000. Of this amount, the Northern California Co. is to receive 80% and the Oro Electric Corporation 20%. A separate company is to be formed to cover the gold dredging interests of the Oro company.

Portola, Cal.—R. B. Young, of Loyalton, has applied to the Board of Supervisors for a franchise to erect lines for transmitting and distributing electricity in Portola and vicinity. An electrc power-plant is to be constructed.

Sacramento, Cal.—The Sacramento Natural Gas Co. has authorized bonds to the extent of $1,000,000 to provide funds for betterments. G. W. Peltier is president of the company.

Seattle, Wash.—Suit has been instituted in the federal court by the United States Government against the Puget Sound Traction, Light & Power Co. to revoke patent issued for five mineral claims situated so as to control valuable waterfalls in the Nooksack river in Whatcom county. The plant of the Bellingham Bay Improvement Co., valued at more than $1,000,000, is situated on one of the claims.

Salt Lake City, Utah.—The United States Government has filed suit against the Beaver River Power Co. and L. L. Nunn, alleging trespass on government lands.

Irrigation and Water Supply

Fresno, Cal.—A committee of 31 farmers, representing the water users of the Kings River district, has adopted a report favor-

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ing the formation of a water conservation and flood-control district, to be known as the Kings River Water Control and Conservation District. One million acres is to be placed under irrigation, at an estimated cost of $6,000,000. Mr. Chandler, of Fresno, is interested in the project.

Sacramento, Cal.—An assessment of $600,000 has been levied upon the outstanding capital stock of the West Sacramento Co., the amount being $10 per share. O. W. Jasper, Jr., is general manager.

Oroville, Cal.—The Sutter Basin Reclamation Co., known as reclamation district No. 1500, has submitted formal plans for the reclamation of the district, and has requested the Board of Supervisors to appoint three commissioners for the purpose of making an assessment against the lands to be benefited. The total estimated cost is $3,331,685, or approximately $50 per acre.

Lakeport, Cal.—The Board of Supervisors is considering the formation of a county water district for the purpose of conserving and utilizing the waters of Clear lake and its tributary streams.

Redding, Cal.—Geoge L. Hoxie, of Fresno, who located 60,000 inches of water in the Sacramento river in December, is having preliminary surveys made for the proposed pumping works and main canal; 250,000 acres are to be irrigated.

Klamath Falls, Ore.—The Secretary of the Interior has approved the application of the Horsefly Irrigation District for the filing of a reservoir site.

Pullman, Wash.—A municipal election is to be held to provide $20,000 in bonds for the purpose of making betterments and additions to the city water system. A concrete pump station, a 100-hp. pump with a capacity of 1000 gal. per minute, and a 60,000-gal. tank are to be installed.

Grandview, Wash.—The Secretary of the Interior has set aside $190,000 for the purchase of machinery for the Grandview, Snipes Mountain, and Outlook pumping plants.

North Yakima, Wash.—Of a total of $1,380,000 allotted to the Yakima Reclamation Project of the United States Government for 1914, $658,000 is to be expended on the Sunnyside unit, $113,000 on the Tieton unit, and $609,000 for storage work. A pumping plant sufficiently large to supply water to 6500 acres will be installed for the Sunnyside unit.

Winona, Wash.—It is stated that a damsite has been located for the Palouse Irrigation project on Rock creek. A dam 2300 ft. long and 100 ft. wide will have to be built, at a cost of $1,000,000.

Walla Walla, Wash.—According to L. W. Loehr, county engineer, it will cost $35,000 to complete the Burbank drain system.

Denver, Colo.—It is stated that the United States Reclamation Service has appropriated $1,873,184 for developing the Grand Valley Irrigation project and $750,861 for the Uncompahgre.

Washington, D. C.—Expenditures to be made by the United States Reclamation Service in the Pacific Northwest in 1914 are as follows: Arrow Rock dam and other features of the Boise, Idaho, project, $3,600,057. Minidoka project, Idaho, $476,874. Huntley project, Montana, $281,000. Milk River project, Montana, $1,393,083, with an additional sum of $843,630 for the St. Mary's storage feature of the Milk River project. Sun River project, Montana, $1,712,337. Okanogan project, Washington, $149,000. Several projects in the vicinity of North Yakima, Washington, totaling $1,380,739. Umatilla project, Oregon, $572,000. Klamath project, Oregon, $175,219.

Personal

Dorsey Hager, petroleum geologist, has returned to Los Angeles.

James E. Sutton has been appointed city engineer for Alameda, California.

H. L. Terwilliger, president of Harron, Rickard & McCone of San Francisco, is in New York.

Andrew Weir and R. Tilden Smith, of the General Petroleum, Ltd., have returned to England.

J. H. G. Wolf has been appointed petroleum engineer in the field for the U. S. Bureau of Mines.

F. W. Brown has been appointed traffic manager for the San Francisco-Oakland Terminal Railways.

Stanley C. Herold, geologist for the Caribbean Petroleum Co., of Maracaibo, Venezuela, is in San Francisco.

Chester Naramore has left Coalinga for

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the Fillmore field to take charge of the W. P. Hammon oil interests.

L. P. Hardy has resigned his position as assistant superintendent of the water works department at Ogden, Utah.

L. G. Krigbaum is in charge of a survey with relation to gathering data on inland waterways for the U. S. War Department.

B. K. Stroud, petroleum engineer of San Francisco, has returned from a trip to the Lost Hills district on professional business.

E. J. De Sabla, Jr., has resigned the presidency of the General Petroleum Co., the vacancy having been filled by John Barneson.

Paul M. Paine has been appointed general superintendent of the Honolulu Oil Co.'s properties, with headquarters at Taft, California.

George P. Hemstreet, of the Hastings Pavement Co., recently lectured before the students in highway engineering at Columbia University.

Arthur H. Blanchard, professor of highway engineering at Columbia University, recently delivered a series of lectures before the University of West Virginia.

Arthur P. Davis, chief engineer for the U. S. Reclamation Service, recently delivered an address to the Utah Society of Engineers on 'Government Irrigation Work.'

J. Paulding Edwards has retired from the position of engineer in charge of electrical and mechanical construction to become consulting engineer for the Northern Electric Railway Company.

Harold Almert has severed his connection with H. M. Byllesby & Co. as manager of their department of examinations and reports, to enter into consulting engineering practice with offices in The Rookery, Chicago, Illinois.

H. C. Kauffman, city engineer, C. S. Stein, highway engineer for California, and W. F. Luning, engineer for Tehama county, have been making a tour of inspection with regard to the selection of routes for the state highway.

John Q. Brown has resigned his position as assistant general manager and engineer for the San Francisco-Oakland Terminal Railways. George St. Pierre has been appointed superintendent of equipment, and Pomeroy Ladue has been appointed purchasing agent.

A. N. Talbot, professor of theoretical and applied mechanics at the University of Illinois, has been appointed chairman of the joint committee on stresses in railway track and subgrade of the American Society of Civil Engineers and the American Railway Engineering Association.

Society Meetings

The National Conference on Concrete Building was held in Chicago on February 12, 13, and 14. Addresses were delivered by W. F. M. Goss, Oliver Dunlap, Edward N. Hines, A. N. Johnson, H. G. Shirley, Arthur H. Blanchard, and many others.

At a meeting of the American Road Builders' Association held in New York on February 6, the following officers and directors were elected: President, W. A. McLean; first vice-president, George W. Tillson; second vice-president, A. W. Dean; third vice-president, A. B. Fletcher; secretary, E. L. Powers; treasurer, W. W. Crosby.

The first 'Safety' conference or Industrial Safety Exposition of the University of Nevada was held at Reno on January 26. Addresses were delivered on the subjects of 'Safety First,' John J. Mullin; L. E. Abbott, Frank Ingram, 'Safety Regulations for Electric Power Companies'; W. K. Freudenberger, discussions by George A. Campbell, Fred A. Mechling, F. O. Broili, H. S. G. Hurlbut, L. W. Crehore, Joseph Bean, 'Electric Headlights,' J. G. Scrugham.

The Idaho Society of Engineers met at Boise, Idaho, on Febuary 6. The following officers were elected to serve for the ensuing year: President, Ern G. Ealeson; vice-president, R. J. White; secretary, Ira F. Shaffner; treasurer, Fred H. McConnell; executive committee, J. P. Congdon, Fred A. Wilkie, E. A. Wilcox. Addresses were given by J. W. Shephard, in charge of construction work in Rogers Pass tunnel for the Central Pacific, on 'Problems and Methods of Fixing Tunnels;' Barry Dibble, of Minidoka, on 'Electrical Manufacture of Nitrate Fertilizer;' and Mr. Bell, mine inspector, addressed the engineers on 'Idaho's Mineral Resources.'

The San Francisco section of the American Society of Mechanical Engineers held a meeting in the rooms of the Engineers' Club

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of San Francisco on the evening of February 10. Robert Sibley, chairman, presided at the meeting. The topic for discussion was 'The Transportation of Crude Oil in Pipe-Lines.' E. I. Dyer, engineer-in-chief for the Union Oil Company of California, led the discussion by reading a paper prepared with special reference to experimental work on one of the oil pipe-lines of the Union Oil Company to determine first, the various factors influencing the loss due to friction in pumping oil and second, the derivation of a formula by which the friction losses could be calculated. Mr. Dyer demonstrated by means of a series of curves plotted from a large number of field observations that all of the variable factors could be combined in one which he termed the 'viscosity co-efficient.' This viscosity co-efficient takes into consideration also the element of time, which is an important factor in gauging the change in the viscosity of the oil as it cools or is heated. Mr. Dyer was followed by Wynn Meredith, and H. W. Crozier, engineer for Sanderson & Porter; A. C. McLaughlin, superintendent of operations for the Kern Trading & Oil Co.; E. T. Morris, manager of the Associated Pipe-Line Co.; Arthur F. L. Bell, chief engineer for the Associated Oil Co.; W. F. Durand, of Stanford University; and R. P. McLaughlin, field engineer for the California State Mining Bureau.

Catalogues Received

Platt Iron Works Co. Bulletin 555-A, 'Smith Vaile Boiler Feed Pumps'; Catalog No. 73, 'Stillwell Feed Water Heaters and Purifiers'; Bulletin 741, 'Triplex Power Pumps.' This bulletin contains much valuable data of interest to pump users in general. It is fully illustrated and shows the extensive application to which this type of pump is adapted. The horizontal as well as the vertical type is shown, together with illustrations of many different types of drive. Tabulated engineering data of interest to hydraulic engineers are also given. Bulletin 755, 'Platt High Lift and Turbine Pumps'; Bulletin 710, 'Victor Wicket Gate Turbines.' Chas. C. Moore & Co., of San Francisco, Seattle, Los Angeles, Portland, Salt Lake City, and Tucson, are western agents.

Richardson-Phenix Co., Milwaukee, Wisconsin. Bulletin No. 57, 'The Phenix Sight Flow Indicator.' This bulletin illustrates and describes how this unique little device can be inserted in any pipe-line carrying a liquid, such as water lines of water cooled transformers and the supply pipes of water jackets of gas engines and air-compressors, and how it shows at a glance or indicates electrically by lighting a lamp or ringing a bell when the flow of liquid is interrupted. Several recent improvements in the sight flow indicator are also described, showing how it is now possible to adjust the indicator so that it will give an alarm before the liquid stops flowing entirely, that is, when it drops to some predetermined minimum. This improvement has made it especially suitable for use on water-cooled transformers. Copies of the bulletin may be had by addressing the company as above.

Lackawanna Steel Co., Lackawanna, New York. Bulletin 106, 'Lackawanna Steel Sheet Piling.' This is one of the most interesting publications that has come to this desk. The data are thorough and in unusual detail. It shows the many applications of this sheet steel piling, not only for temporary purposes, but for permanent bulkheads, levee work, docks, and sea-walls. Every contractor will be interested in the information contained therein and will have no difficulty in appreciating the saving that can be achieved with this type of steel piling, as compared to the wood sheet piling which is used so much on the Pacific Coast.

Pelton Water Wheel Co., San Francisco and New York. Catalog illustrating and describing Pelton water wheels of both the turbine and tangential types. This catalog differs in a marked degree from the ordinary trade catalog in that it resembles a text-book on the general subject of hydraulic prime movers, rather than a trade publication. While it is ostensibly devoted to water wheels only, many illustrations and much descriptive matter deal with the general subject of water-power plant design and construction, as well as many examples of dam, forebay, and power-house construction. Engineers, especially, will appreciate the reference tables given, which include weir measurement, tables of horse-power for tangential wheels, safe working heads and weights of riveted steel pipes, and types of lap-welded steel pipe joints.

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